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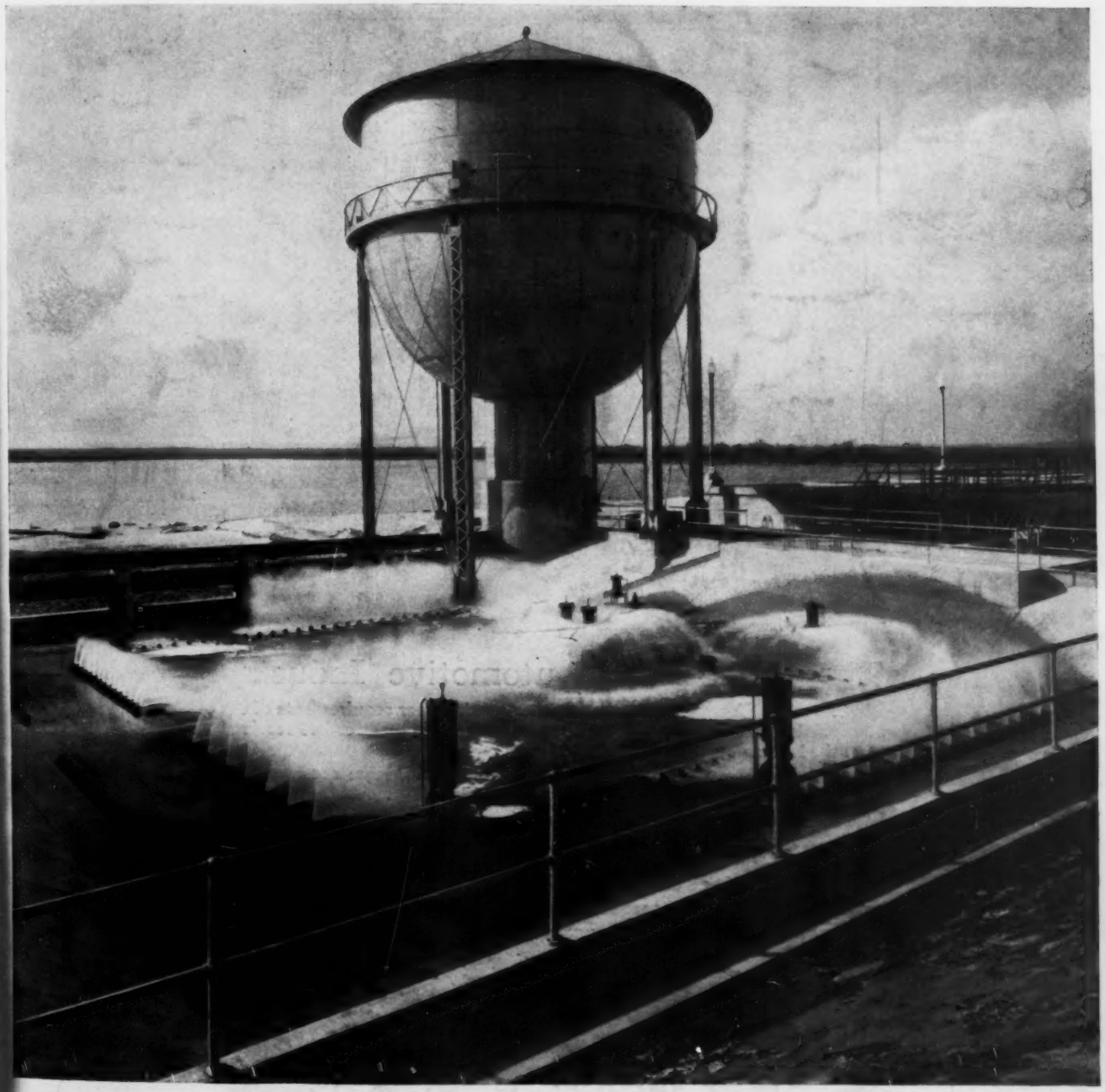

Effluent Aerators and Wash Water Tank, West Palm Beach, Florida, Water Supply

Five Articles for Water Works Men in This Issue

Second Article on Winter Construction Methods

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FRANK C. WIGHT
Editor

Volume 99 NEW YORK, SEPTEMBER 8, 1927 Number 10

Engineering Principles and the Farmer

TWO weeks ago a delegation from the American Society of Agricultural Engineers submitted to President Coolidge a program for the reform of agriculture in the United States. Rapid City, where the President received the delegation, is full of newspaper men, hungry for copy, so the full text of the recommendations has had wide circulation and extensive editorial comment. Almost without exception this comment has run along the same lines. Here is at last a sane view of the agricultural problem. The proposals are reasonable and authoritative; if followed they would surely lead the farmer out of his hopeless struggle to put prices somewhere above costs. But the rub, say the editors, is that there is no way of putting the plan into execution. It is just another of the impractical dreams that engineers have when they step out of the elementary routine of design and construction. What the farmer needs is something practical, something that will work, and the engineer doesn't seem to give him that. So speaks public opinion through the press, and the real friends of the farmer continue to fall back on the illusion of price fixing. Immediate cure of a serious disease is what the farmer has been crying for for a generation, and crying for in vain. Isn't it perhaps time for the long view to be entertained? Industry developed by the slow application of just the same principles the agricultural engineers are now suggesting for farming. It may be that only time can work the cure for the farmer.

Rain and Roadbuilding

WITH the end of the "third wettest August" since 1871 commiseration with road builders is in order. Occasion, too, is offered for comment on the fact that of all hindrances to steady profitable road-construction output, those due to rain are accepted with the least show of determination to find preventives. In a study made by the Bureau of Public Roads of losses in concrete road construction, one-half of all time losses is charged to weather—rain, cold and frost. As a rule delays due to actual frost are small, and cold weather milder than freezing acts only to prolong the period for which the effects of rainfall hinder construction. Substantially, then, rain is the whole weather cause of time loss in fine grading and paving for concrete roads, and be it remembered weather losses are a half of all time losses. Obviously we cannot prevent rainfall. Just as obviously as engineer road builders we may not be satisfied to stop with this conclusion. Studies of rainfall delays are the first step. We possess at present very few. They, however, offer encouragement. That of the Bureau of Public Roads, for example, shows that it is not inches of rainfall but continuity of light rains, ½ to ¾-in. falls, which most delays construction. It shows that rain in the hot months is less a hindrance than in cold months. It shows that failure to provide means by which the subgrade will quickly drain off rainfall prolongs rain delays. In general it indicates "that a goodly proportion of the time lost now as the direct or indirect result of rainfall is not inherent in the nature of the physical conditions, but rather, at least in part, is due to difficulties inherent in or connected with the present methods of operation and management." These are conclusions which challenge the road builder to take stock of his practices before accepting weather delays as irremediable dispensations of Providence.

Four Water Aerators

ASIDE from the utilization of head otherwise lost, the aerators at four water purification plants described elsewhere in this issue are notable because of the way in which the application of the same general principle is modified to meet local conditions. Differences in climate at Providence and West Palm Beach, for instance, cause housing of the control devices at the northern plant while at the southern they are exposed, as shown in the latter case by the general view of the West Palm Beach aerators. All the views illustrate the heightened scenic interest of filtration plants caused by aerators. Important as the scenic aspects of these aerators is, the moving reason for installing aërators in each case was utilitarian, a fact that may be commended to the attention of the municipalities in the North Jersey Water Supply District in connection with the Wanaque aqueduct controversy, in which one side urges that the aerators originally proposed should be converted into mere fountains for landscape effect.

A Flood Year

IF FOR convenience we close the current summer's account with the end of August, we look back on a season likely to be long remembered for its floods. Wet conditions seem to have prevailed over a large part of the world. Rainfall was abnormal, or at least unseasonable, not in one country or continent but many. Reports of destructive floods came from the most various parts of the globe—this week Poland adds to the list—and they included not only cloudburst freshets on small brooks and runs but also floods of large area, due to distributed rainfall. In the losses sustained we have an illustration of the flood hazard to which a large part of the world's richest regions is exposed. This is a hazard which grows steadily greater, by virtue of the continuous changes wrought by human development. Its elimination or at least control is still far off. Before it can be approached there must be much more thorough study of flood facts than has yet been carried out, despite the extensive flood literature already accumulated. A particularly large field of work is offered by our own country.

We pointed out a few weeks ago that the opportunity is at hand to take up this work now. It is a national obligation, and one that Congress might well recognize in its coming session. It would be quite fitting were the flood year of 1927 to be marked by the beginning of work on exhaustive, systematic collation of American flood data, as a contribution to the future security of mankind.

Secrecy as to Typhoid

APPARENTLY there are still people who regard it a disgrace to let it be known publicly that a relative or friend is ill or has died of typhoid fever. Thus a cablegram in a New York evening paper recently announced that a prominent Chicagoan was seriously ill of typhoid in London. Next morning a cable to another New York paper gave the illness as nervous trouble. In later cablegrams the cause of the illness was not mentioned. When the end came the London dispatch to the New York morning paper gave typhoid as the original cause of illness but a cable dispatch to a Chicago paper said the original malady was "intestinal trouble." Typhoid has been at low levels in both London and Chicago of late. Perhaps the press correspondents of the two cities have formed an alliance of silence as to occurrence of the disease. It would be interesting to know whether Montreal, with its over 5,000 cases of typhoid since February, was responsible for the death from typhoid in London of a citizen of Chicago. Only the recording angel will ever know how wide flung have been and will be the seeds of the Montreal epidemic.

Once More No Epidemic

NEWSPAPER men continue to preach the theory that all great disasters breed epidemics—and continue at the same time to express surprise or thankfulness that each particular disaster as it comes along seems to have escaped the sequel of disease. The latest instance is the New York *Times* which, in editorial comment on the official toll of damage from the Mississippi flood, says: "Fortunately the actual toll of human life was insignificant, and as yet the dreaded epidemics have not set in." They did not set in after the San Francisco earthquake, they did not set in after the Galveston flood, they did not set in after the Florida hurricane. But that will not stop the newspaper men from wailing about the possibility of epidemic every time the orderly course of human activity is disturbed by untoward events. A short course in epidemiology might be included in the curricula of our schools of journalism.

Colored Highways

TEXAS is a colorful state. Its history and its landscapes and its politics all are variegated. Now it proposes to color that drab thing, the concrete road, unrelieved heretofore except by the random stripings of asphalt crack-filler. Cameron County on the gulf, way down in the southeast corner next to Mexico, plans to make its new six-million-dollar system of highways of green concrete "which will harmonize with the rich semi-tropical verdure and growing crops." It is an excellent decision. And there is modern precedent. Of late years many concrete roads built in parks and on private estates have been tinted and that eminently practical organization, the Portland Cement Association, has rather encouraged the extension of the practice. Of course colored concrete is old as an architectural resort. By these tokens it is quite fitting that public highways of concrete should be colored, and green is an admirable color. We hope that the "experiments" which Cameron County, Texas, is making to "ascertain the quantity of coloring matter to be used and the additional cost it will entail" will be encouraging and that the concrete roads colored green will be constructed.

Sense and Sentiment

OCCASIONALLY, out-of-date equipment is still found operating on construction work; usually, it is inefficient and often it is unsafe. A recent interesting example was the use of an old single-cylinder steam engine direct-connected to a 12-in. centrifugal pump, being used to unwater a cofferdam for a large bridge pier. The engine mounted on the topmost tier of bracing in the 40-ft. deep cofferdam, kept the workmen on constant tension by the excessive vibration which it gave to the crib, while escaping steam added a touch of realism to the potential danger. Why does a contractor use such equipment? It is hard to think of any reason unless it is one similar to that which prompted Christopher Morley to write in one of his published letters: "And *Saxonia's* engines are worth listening to and worth seeing; no turbine oil-burning business but the real hell-raising, crashing rhythm of quadruple expansion cylinders; and an old-fashioned stokehole next door." Fine sentiment, but not much sense from an efficiency point of view. Contractors who still persist in using out-of-date equipment could probably substitute for their sentiment a few calculations on the cost of operating modern construction machinery and find a way to increase their profits.

A Problem in Water-Works Administration

MOST of the publicly owned water-works systems of the United States and Canada supply only one municipality or, if more than that, only some relatively small outlying district. Here and there adjacent municipalities, generally of small size, have joint works. In such cases problems of administration are simple, the larger municipality supplying water at wholesale to outlying districts or two or three municipalities co-operating in joint ownership. Exceptions to these simple arrangements have increased in number with growth and density of population and in rival claims to the same water gathering areas. At first these exceptions were chiefly in what might be called metropolitan districts, but latterly contiguous communities, relatively small in size, have found co-operation in the provision of sources of supply advantageous.

Methods of administering these larger and more complicated water undertakings are many but all are in charge of a commission. Governors, justices of state and county courts, county boards of supervisors, sometimes one and sometimes the other, or some of these in combination, appoint district water commissioners. In other cases, representatives of the constituent municipalities appoint the commissioners, these being sometimes the mayors and sometimes the councils. It is the exception rather than the rule that district water commissioners

are chosen by election. Whatever the means by which these commissioners are put into office, rarely are they held clearly responsible to anybody in particular, except where elected by popular vote.

The normal thing to expect under governmental systems and conditions prevailing in the United States and Canada is that a water district composed of two or more municipalities would be a municipal corporate entity and thus self-governing. Carried to its fullest extent, the old American tradition would require that the commissioners be elected by popular vote, but inasmuch as the duties of these commissioners are essentially administrative, the newer ideas call for appointment, but by some elective authority within the district.

A recent California statute providing a method for the creation of metropolitan water districts, apparently designed primarily for some 40 municipalities in southern California, provides for representatives from each municipality in any created district, appointment to be made by the chief executive officer and confirmed by the legislative body of the corresponding city. Each municipality is to have at least one representative and in any case one vote, but to adjust the number of representatives to agree with the size of the municipalities, the act provides for representation in proportion to assessed valuation. The reason for this method of apportionment rather than by population is not apparent and in the absence of reasons supported by argument does not seem to be justified.

Unsatisfactory experience with the district water and sewerage commissions in New Jersey, both lacking municipal corporate power, has led the legislature of that state to submit to popular vote on Sept. 20 of this year a constitutional amendment authorizing the legislature to create water and sewerage districts, with corporate powers, and with commissioners chosen by popular vote. Had such a constitutional amendment been adopted decades ago, it would have provided the people of northeastern New Jersey, the most densely populated section of the state, with a means of handling their water supply and sewage problems far more efficiently and economically than they have been administered under district commissioners appointed by successive governors, responsible to nobody in particular, having no power of raising money, but having unlimited power of spending it as they chose once it was provided by the municipalities whose agents the commissioners are. The need for a decided change is quite well understood by members of the engineering profession in New Jersey and it is reasonable to expect that they will not only cast their vote for this amendment but use their influence within the next two weeks to roll up a large vote for it.

Construction Fire Hazards

THE destructive fire in the timber centering of the Mount Washington bridge at Pittsburgh, noted in our news columns last week, calls attention once more to a too often overlooked hazard of construction. Fire is not, as a rule, a matter of serious concern to the constructor. There are exceptions, of course. Occasionally one runs across a job where every precaution has been taken to provide protection against conflagration not only by the proper use of the temporary erecting material and by the disposition of the temporary structures but also by provision of fire fighting equipment. But more often the assumption is that a construction operation is not a favorable medium for spread of fire and that the close supervision a construction job necessarily has is about all that is needed to keep fire from either starting or spreading.

Numerous instances, such as that of the Pittsburgh bridge and the Netherlands Hotel fire in New York some months ago, show that fire can start even in the apparent security of widely spaced timber members, and that once started the difficulties of control may be much greater than in the finished building in a city guarded by all the details of a municipal fire fighting force. Further than that, a construction fire causes a double loss of construction equipment and of the structure itself, as the contractor of the Mount Washington bridge now knows.

Contractors would do well, then, to think more of this hazard. Since the ruling in the New York courts a few years ago that concrete forms and centers are contractors' tools and therefore not properly included in the insured property of a building under construction, wise contractors have taken the precaution to cover their entire plant and equipment when taking out policies on a building being erected. They have, too, seen to it that fire protection in the way of extinguishers, water barrels, hose lines, etc., are part of their plant. On the contrary, they have done little in the way of providing fire safe erection material.

Rarely, for instance, has any one suggested that metal forms and metal centering have advantages in fire safeness. Within the fire department limits of the city it is possibly far fetched to give much weight to the added protection of metal forms and struts, though it may be noted that there have been bad fires in city buildings under construction and that in the reconstruction of the Netherlands tower steel falsework is being used. But when it comes to the isolated job, where the contractor has to provide his own fire fighting equipment, the added value of a non-burnable temporary frame is worth considering.

Particularly is this true of the large concrete arch bridges, which require a veritable forest of posts and braces for temporary support of the ribs. The steel-arch center has many advantages for concrete arch construction, but it is used less frequently than it might be because of its high first cost. If the added protection against fire that it brings be entered in the equation, however, it would be adopted more frequently than it is. The contractor figuring on the falsework for a new arch should contemplate those masses of concrete now reposing under the Mount Washington bridge, and weigh the possibilities of a similar disaster against the cost of a centering that will not burn. If his bridge is over a stream subject to sudden high water he always credits a large sum to the centering that will resist or avoid flood. He is under equal obligation to consider the serious consequences of a fire that not only will destroy structure and equipment but will postpone completion of the job to his loss.

The National Fire Protection Association has recognized the serious nature of this problem by appointing a committee on construction fire hazards. The committee has not yet had time to do more than organize, so that results from it may not be expected for some time. It has ahead of it, however, a real job, not only in a study and analysis of the extent and causes of construction fires but in publicity regarding the precautions that must be taken to reduce the hazard.

Effluent Aerators Control Mechanical Filters

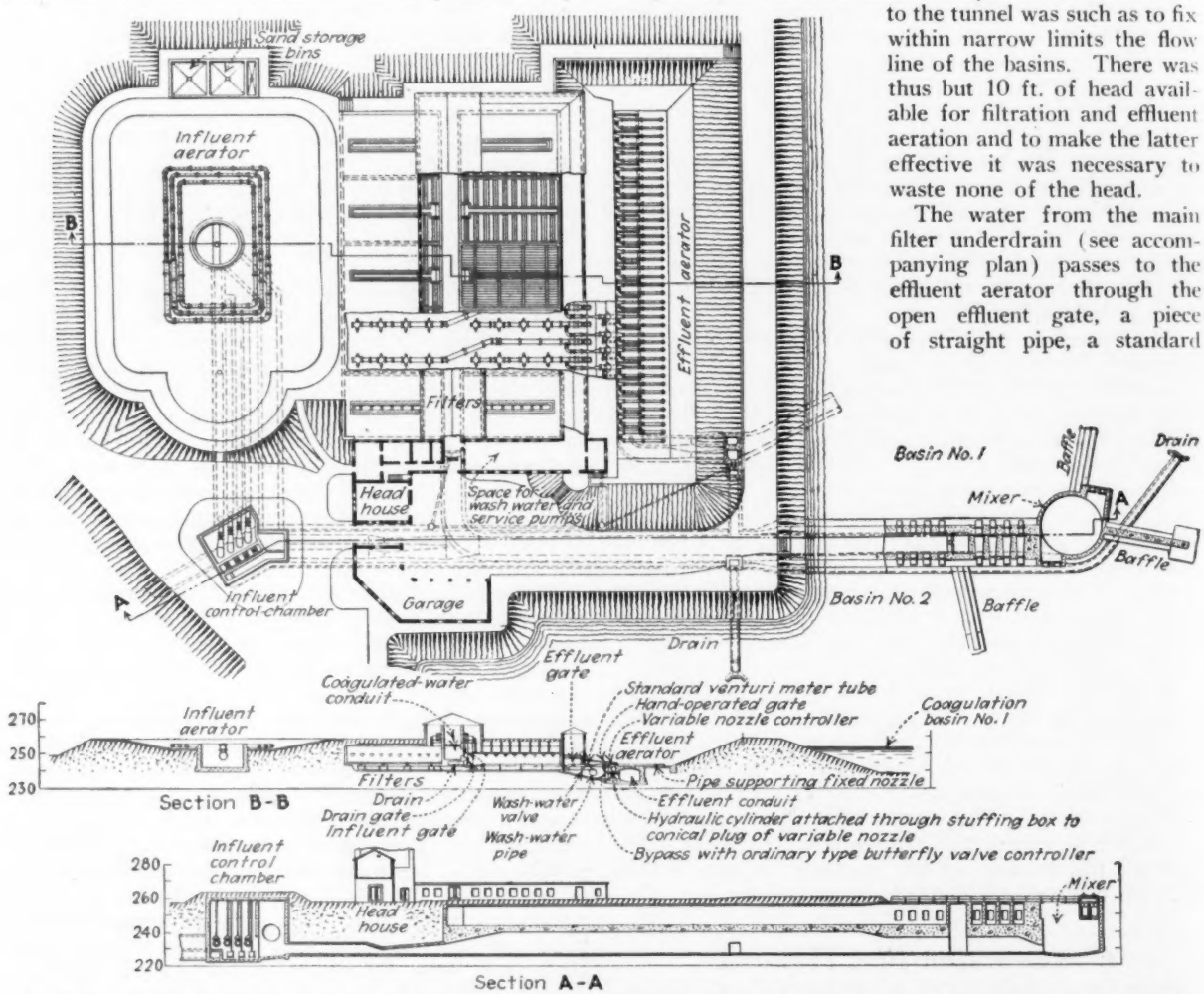
Plants at Providence, West Palm Beach, Poughkeepsie, and Rahway Utilize Head Between Filters and Clear Well

By Malcolm Pirnie
Of Hazen & Whipple, Civil Engineers, New York City

FINDING uses for byproducts of manufacturing processes often increases dividends. In the process of water purification, dividends in improved quality may be obtained by employing for aeration that portion of the head between the water on the filters and in the clear well which remains after the water passes through the filters. This is done by attaching to the effluent pipe spray nozzles sufficient in number to discharge the rated capacity of the filter when clean and also a variable nozzle which opens gradually to maintain the rate of filtration constant as the filter clogs. Carbon dioxide and gases productive of taste and odor are considerably reduced by exposing the clarified water to the air in the form of a spray resulting from the variable effluent head acting through the nozzles.

Providence Effluent Aerator—The filters for Providence, R. I., were designed after the construction of the tunnel leading toward the distribution system was well under way thus fixing the elevation of the filter effluent. The contour of the valley in which the large open coagulation basins were laid out adjacent to the entrance to the tunnel was such as to fix within narrow limits the flow line of the basins. There was thus but 10 ft. of head available for filtration and effluent aeration and to make the latter effective it was necessary to waste none of the head.

The water from the main filter underdrain (see accompanying plan) passes to the effluent aerator through the open effluent gate, a piece of straight pipe, a standard venturi meter, a tee, an open manually operated gate, the special variable nozzle tee, all in the pipe gallery beneath the operating room and concrete apron of the effluent aerator; then through the pipe gallery wall and through the fixed nozzles on two pipes on the floor of the outdoor effluent aerator basin. As the filter clogs, the head on the fixed nozzles is reduced, resulting in less discharge through them. The Builders' Iron Foundry diaphram controller, on the floor of the pipe gallery, then



INFLUENT AND EFFLUENT AERATOR AND PIPE CONNECTIONS, WATER FILTRATION PLANT, PROVIDENCE, R. I.

moves to the change in head differential of the venturi meter, actuating a pilot valve which operates a hydraulic cylinder under the variable nozzle tee. The cylinder is connected through a stuffing box to a conical plug fitting the outlet branch of the special nozzle tee which projects above the aerator basin apron. The plug is automatically raised until the water sprayed through the opening produced is sufficient to maintain the rate of filtration for which the controller is set.

Next to and parallel with the pipe gallery under the aerator floor is located the effluent conduit. Aerator water from the basin enters the conduit through vertical 8-in. slits in its arched top. The effluent conduit carries the water through twin venturi meters and under the bottom of coagulation basin No. 1 to the tunnel leading to the distribution system. Provision is made for applying lime and chlorine to the water just before it enters the twin meters, only one of which is used at present.

When for any reason it is desirable to bypass the effluent aerator the manually controlled valve is closed and the control is shifted to a standard type hydraulic butterfly valve in a pipe leading from the tee in the effluent line at the downstream end of the venturi meter and discharging through the pipe gallery wall into the effluent conduit.

All of the valves, controls and operating mechanism are located in the filter building with the exception of the conical plug in the variable effluent nozzle, the only moving part exposed to the weather. This is close to the main stream of effluent water and is therefore not likely to freeze shut in ordinary winter weather.

Provision for effluent aeration at Providence necessitated the division of operation controls into two galleries. The one next to the aerator controls all operation except washing. The gallery between the filters is on top of the coagulated water conduit and contains the controls for washing the filters so that the operator, during washing, can observe the condition of the beds. The pipes from the wash-water gate control handles, on the filter operation tables in the central gallery, pass through locking devices before reaching the hydraulic cylinders on the wash-water gates which are connected with the effluent gate controls in such a way that it is impossible to open a wash-water gate from the central gallery unless the effluent gate is closed. With all the gages located in the effluent gallery and the influent gates operated from this point, there is no cause for an operator to leave the effluent gallery except for the short period required to wash a filter.

To operate a filter at less than nominal rate when clean a proportion of the fixed nozzles equal to the reduction required in rate may be unscrewed from the effluent pipes and standard 3-in. screw pipe plugs inserted in their place. In summer time a number of the nozzles may be plugged with pine plugs but screw plugs should be used in winter weather to prevent freezing of the nozzles. With the available capacity of the variable nozzle and the ability to bypass the full nominal rate of the filters, there can be no objection to cutting down the number of fixed nozzles close to the average filter output, thus operating the entire filter area at less than nominal rate, which will secure better effluent aeration and longer filter runs.

West Palm Beach—In southern Florida water-works design is greatly simplified by the lack of freezing weather. It is possible to locate hydraulic cylinders in the open and to build mechanical filters without covering and with the pipe gallery equipment and small pipes running to hydraulic valves exposed to the weather. These fortunate circumstances were used to reduce the cost of construction in the new 20-m.g.d. filter plant and pumping station built for the West Palm Beach Water Co. in 1926 by the Turner Construction Co. (*Engineering News-Record*, June 30, 1927, p. 1048).

PROVIDENCE EFFLUENT AERATOR IN ACTION UNDER TWO DIFFERENT CONDITIONS

1—Effluents from three filters under variable loss of head; at right, effluent from cleanest filter; at left, effluent from dirtiest filter.

2—Winter view, showing sprays from control at rear. All operating parts are in cellar beneath aerator floor to prevent freezing.

The main features of the plant are built to allow the capacity to be doubled when necessary by the simple addition of more coagulation basin capacity, filters and an extension of the effluent aerator. As at Providence, the raw water is colored and extremely soft and requires careful treatment to produce an inactive water without noticeably increasing its hardness. To attain this end the water is aerated twice, first after receiving the dose of coagulant in a spray into the coagulating basins and then in an effluent aerator controlled in a manner similar to the control of the Providence effluent aerator.

The pumping station is located on the old lake bottom close to the new shore line of the source of supply with the raw water in a channel under the low-lift pumps along the south side of the pump room. Part of the clear water reservoir extends to a chamber under the opposite side of the pump room over which the high-lift pumps are located and the discharge pipes for both pumps are in a gallery between the raw and filtered water chambers. Chemical storage and dry-feed machines are located in the pumping station and the chemical feed is controlled from a small room on one side of the main pump room. The electric switchboard for operating the pumps is placed next to this. In an opposite corner of the pump

room is an operating table from which, through hydraulically operated valves, all operation of the filtration plant is controlled, with the exception of filter washing. The loss of head and rate of flow indicators are set upon this table with the diaphram controllers and mercury float wells in a pit beneath the floor, and gages of water levels in the wash-water system and in the standpipes of the distribution system are placed upon the wall close by.

With the exception of washing the filters, the entire operation of supplying water to the city is controlled from the main pump room and reduces to a minimum the size of the operating force.

this point there is a tee, one branch of which is connected with the effluent conduit under the aerator basin through a typical butterfly valve controller. The other branch passes through a manually controlled gate, a variable nozzle tee with the hydraulic control and conical plug in the open on top of the nozzle and continuing to pass around half of the perimeter of the aerator basin on which are attached the fixed nozzles. This pipe is divided in the middle by an exposed hydraulic valve which serves to cut the rate of delivery of a clean filter to half the nominal rate at the will of the operator in the pump room. The control mechanism may be changed

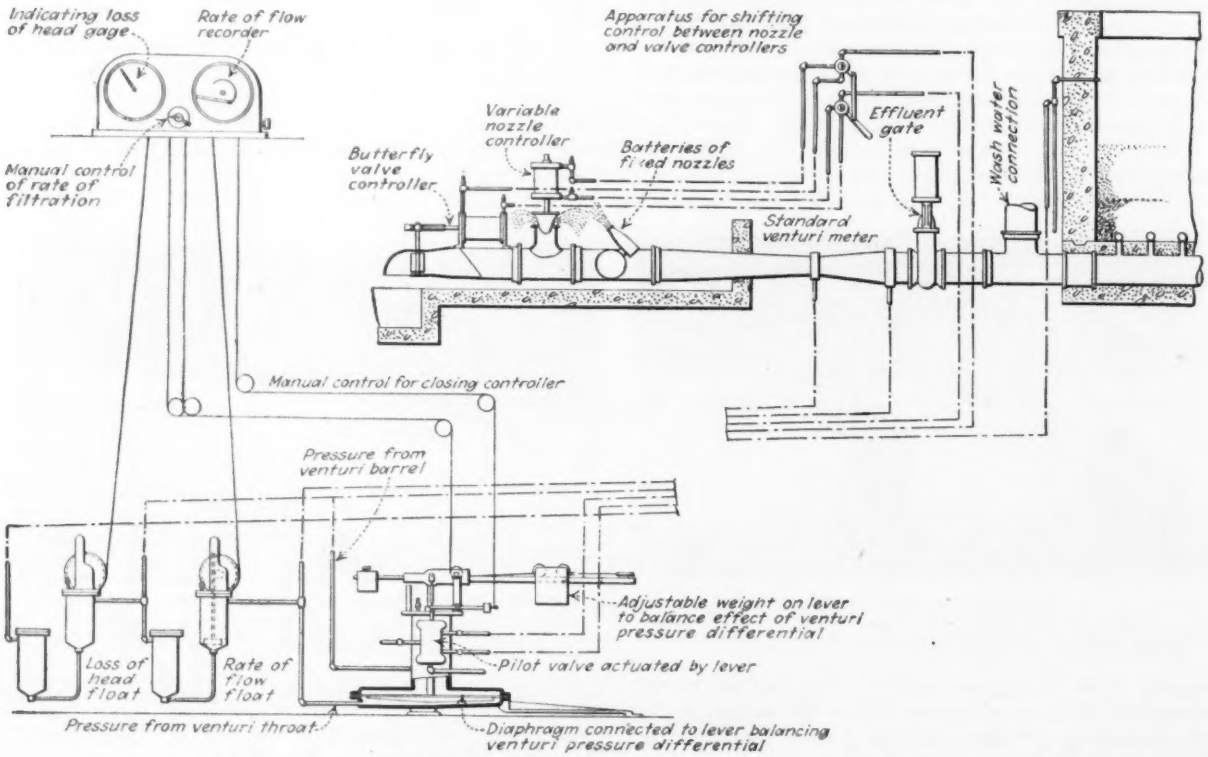

Indicating loss of head gage
Rate of flow recorder
Manual control of rate of filtration
Apparatus for shifting control between nozzle and valve controllers
Variable nozzle controller
Butterfly valve controller
Batteries of fixed nozzles
Effluent gate
Wash water connection
Standard venturi meter
Manual control for closing controller
Pressure from venturi barrel
Adjustable weight on lever to balance effect of venturi pressure differential
Pilot valve actuated by lever
Loss of head float
Rate of flow float
Pressure from venturi throat
Diaphragm connected to lever balancing venturi pressure differential

DIAGRAM OF METHOD OF FILTER CONTROL BY MEANS OF EFFLUENT AERATOR, WEST PALM BEACH, FLA.

There are four 5-m.g.d. filter units, each divided into four sections for washing. The pipe gallery between the filters contains simply the main effluent pipes for each of the four filters and their connections to the center of each quarter section with a single gate on each. The wash-water manifold goes through gates into each of the main effluent pipes just above the effluent gates. The water after passing an effluent gate goes through a standard venturi meter and into the effluent aerator basin. At

from the nozzle to the butterfly valve control as desired, and the manually operated valve on the effluent aerator line must be closed to produce bypassing of the aerator basin. An accompanying diagram of the apparatus used for effluent aeration control at West Palm Beach gives a clear idea of the simplicity of the arrangement. The special apparatus was worked out in co-operation with us by F. N. Connet of the Builders Iron Foundry, which furnished the controlling equipment and the venturi

TABULATION OF RESULTS OF FILTER OPERATION WITH EFFLUENT AERATION

	Free Carbonic Acid				Hydrogen-Ion Concentration				Alkalinity			Alum Dose	Lime Dose	Color	
	Treated	Filtered	Effluent Aerated	Final	Treated	Filtered	Effluent Aerated	Final	Raw	Effluent Aerated	Final	Gr.p.g.	Gr.p.g.	Raw	Final
Providence, av. for Feb. 1927	10.7	7.8	5.3	1.8	5.8	6.0	6.2	7.3	5	1	5	0.68	0.20	33	4
Providence, av. for June 1927	6.2	3.4	2.6	0.8	6.1	6.4	6.6	7.6	4	1	4	0.54	0.1	28	4
West Palm Beach, July 1-14, 1927	10.0†	7.5	4.4	3.9	...	5.5	5.8	6.4	30	0.14	5.2	4.4	*	62†	12
Poughkeepsie pre-filtered, April 6—July 21, 1927	....	13.6	8.3	7.9	...	6.5	...	6.7	44	28	28	2.16	0	21	5
Rahway, week ending July 10, 1927	12.7	12.3	4.7	5.0	7.0	7.3	7.3	7.3	86	56	56	3.5	0	37	3

* 5.1 per cent aerated well water mixed with effluent. Well water as follows:
Color 54. Alk. 116.0. Free CO_2 1.0. pH 7.7.

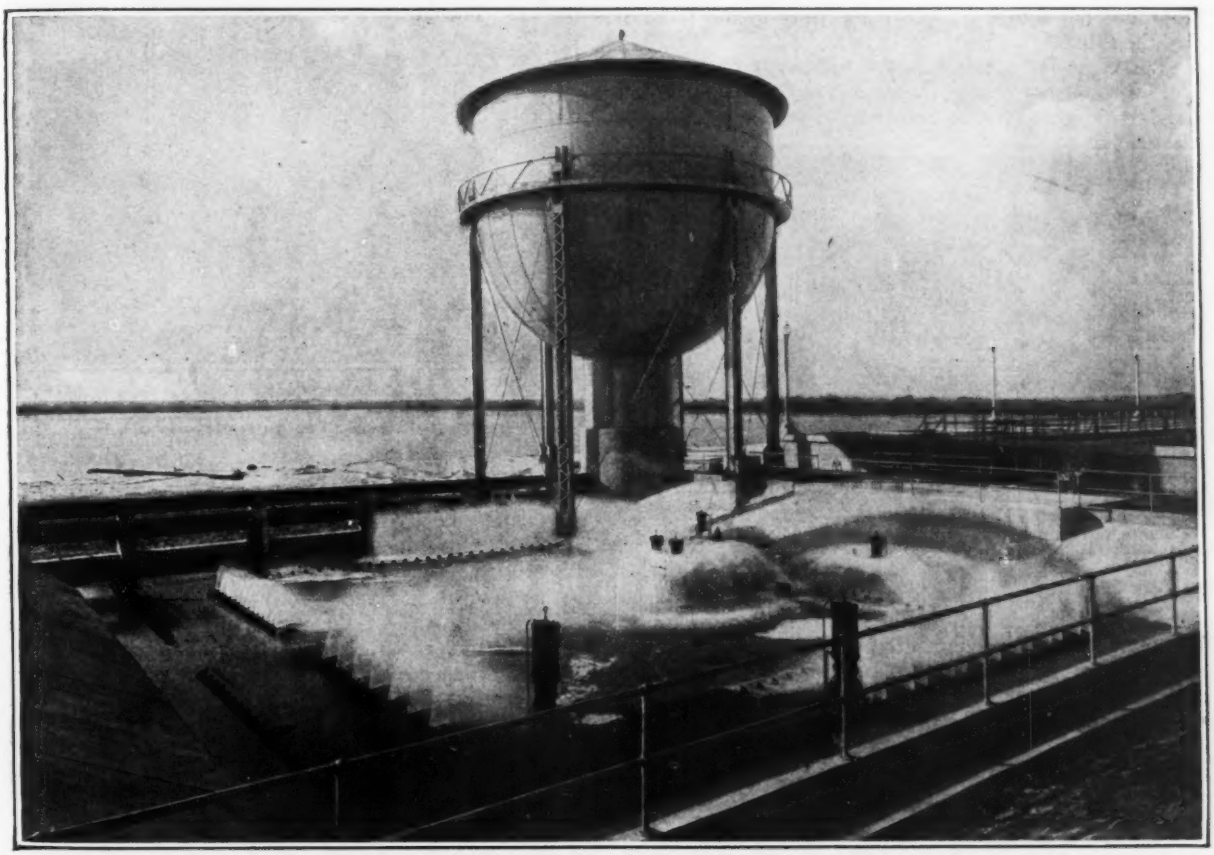
†Color from analysis of U. S. Geological Survey Lake Mangonia water collected June 24, 1927. Dredging operations in Clear Lake produced turbidity of 50 p.p.m. interfering with color determination of raw water as delivered to plant and increasing required alum dose.

meters both for West Palm Beach and Providence filter plants.

Scrubber Effluent Aeration at Poughkeepsie—In the treatment of the Hudson River water at Poughkeepsie, N. Y., coagulation and mechanical filtration are provided in advance of slow filtration. Effluent aeration was installed between the mechanical filter and the flow line of the slow sand filters to use all of the head for aeration remaining after the water passes through the mechanical filter. Rate control is effected by shutting off sections of the fixed aerator nozzles by means of manually controlled valves in the effluent aerator line and supplying, through a special float-control nozzle, whatever additional quantity of water is required to maintain a constant flow line in the slow sand filters. This device uses all of the head available between the coagulating basin and the flow line of the slow sand filters for passing the water through the mechanical filter and breaking it into a fine spray.

Rahway—The old filter plant at Rahway, N. J., has just been reconstructed to use to their capacity the existing coagulating basins and clear-water reservoir. The clear-water reservoir is located considerably above the level of the pumping station floor and the floor of the building which housed the old pressure filters. A new gravity filter designed for sectional washing was built and the old pressure filters removed. An effluent aerator similar to that in operation at Poughkeepsie has been installed in the pressure filter building, where the water from the clear water reservoir is discharged through spray nozzles and a float control nozzle to a constant level serving the suctions of the high-lift pumps which deliver water to the distribution system. This arrangement for Rahway worked out most satisfactorily for a water which had been giving considerable trouble from tastes and odors. Formerly there was almost always a taste of chlorine in the water and at times other tastes attributed to waste from a dye works above the intake. The present arrangement at Rahway provides for chlorination of the filter effluent as it passes to the clear-water reservoir. The chlorinated water is held in the reservoir for several hours before it enters the effluent aerator. In this way there is ample time for the chlorine to attack objectionable bacteria before the water is aerated. When the water contains residual chlorine higher than necessary, the excess is expelled in the effluent aerator. No tastes are now noticeable in the supply as delivered from the plant and the results in reducing the activity of the water are very marked as shown in the table of analyses. Attention should be called to the fact that the Rahway plant has nearly a constant head of 10 ft. on the effluent aerator except during short periods when the filters are being washed and the level in the clear well is reduced accordingly.

In the Providence and West Palm Beach plants and in the Poughkeepsie effluent aeration, the head on the aerator nozzles reduces as the filters clog and the average head is considerably less than it is at Rahway.

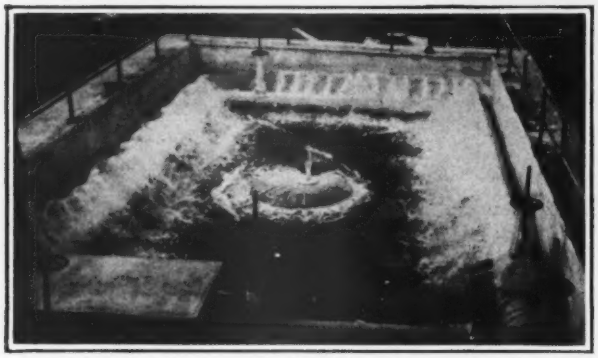


EFFLUENT AERATOR AND WASH-WATER TANK AT WATER FILTRATION PLANT, WEST PALM BEACH, FLA.
Shows exposed cylinders of controllers and four hydraulic valves dividing fixed nozzles of each filter in half. End of open filters at right. At Providence the controllers and valves are placed below aerator floor, to prevent freezing.

Greater efficiency in effluent aeration may be obtained by washing these filters at lower losses of head or by using more spray nozzles with smaller orifices so as to produce finer sprays with the lower heads.

The results of operation of the effluent aerators are shown in the table. An increase in pH varying from 0.2 to 0.3 of a unit and reduction in carbon dioxide varying from 1 to as high as 7½ p.p.m. are secured. The natural aeration of the water in the large coagulating basins at Providence produces a considerable reduction in carbon dioxide before the water comes to the filters. The effluent aerator therefore is not as effective in the summer as it would be expected to be in the winter when the basins are frozen. The whole operation at Providence results in an inactive water by the addition of as little as from 3 to 4 p.p.m. of alkalinity in the form of hydrated lime.

The West Palm Beach hydraulic dredging operations were in progress during the period recorded, necessitating a relatively high dose of alum in treating the water.



EFFLUENT AERATOR OF POUGHKEEPSIE PRE-FILTERS
Shows float control in central nozzle to flow line of slow sand filters.

It is to be expected that a better average effluent will be secured when the dredge is sufficiently removed from the plant to reduce the amount of turbidity present. In the operation of the Poughkeepsie pre-filter, considerable reliance is placed upon the slow sand filters in completing the purification process, and doses of alum less than those producing an excellent floc on top of the pre-filters are used. It is believed that with greater clarification of the water passing to the pre-filters, a greater removal of carbon dioxide would be secured sufficient to offset additional acidity contributed by a small increase required in the alum dose.

Further experience with designs for effluent aerators will indicate how far it is reasonable to go to secure additional removal of carbon dioxide. The removal of tastes and odors seems to be entirely satisfactory in the four plants outlined in this article.

With Reference to San Gabriel Controversy

Through misunderstanding of a telegram on which was based a news item headed "San Gabriel Dam Contract Award Delayed by Injunction," appearing in *Engineering News-Record*, July 28, 1927, p. 157, the name of Louis C. Hill was mentioned as one of three engineers opposed to building the San Gabriel dam at the lower of the two proposed heights. Mr. Hill did not participate in this matter and where his name was mentioned in that note reference should have been to J. A. Bell.

Defective Concrete Wingwall Falls at Indianapolis

ON JUNE 20 a 50-ft. length of riverbank wall on the west side of the White River in Indianapolis toppled over toward the river, killing one man. The wall was of T-section, was about 12 ft. high above the base, and served as a bank-protection wing downstream of the Emerichsville dam. Originally it extended from the abutment of the dam several hundred feet downstream, but the part nearest the dam was demolished eight or ten years ago. The part that fell on June 20 was the next section downstream. It had for some time been of no use and abandoned, as a new wingwall has been built at the dam and a new flood-protection apron nearby.

FIG. 1—REMAINING SECTION OF INDIANAPOLIS WALL
The face of the wall is seen to be full of honeycombs and the concrete at the base to be badly disintegrated.

A view of part of the remaining section of wall is reproduced in Fig. 1, from a photograph taken by Norman M. Stineman, of the Portland Cement Association, the day after the collapse. Mr. Stineman reports that "the concrete was badly disintegrated on the front and rear faces, and in places the base was badly disintegrated (as much as 18 in. deep) and undermined. The vertical reinforcing steel at the back of the wall was completely exposed above the base for a length of as much as 3 ft.

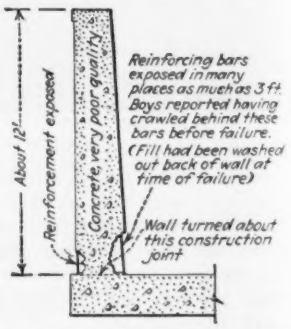

About 12'
Reinforcement exposed
Concrete very poor quality
Reinforcing bars exposed in many places as much as 3 ft. Boys reported having crawled behind these bars before failure. (Fill had been washed out back of wall at time of failure)
Wall turned about this construction joint

FIG. 2—SKETCH SECTION OF FAILED WALL

"Pieces taken from the failed section of the wall indicate that there was little or no bond between the concrete and the steel. A visual examination of the concrete indicates that very little cement was used in the mixture and that the concrete was extremely porous. The appearance of the concrete raises the suspicion that considerable lime may have been used in the mixture."

While there was no fill back of the section of wall that fell, the part still standing (Fig. 1) has earth backing, but strangely enough has not yet fallen over.

Tunneling for City Railway at Sydney, Australia

Twin Tunnels Have Brick Walls with Arch and Flat Roofs—Walls First; then Roof; then Dumpling Removed

ON THE underground portion of the new rapid-transit railway at Sydney, New South Wales, the first section of which is now in operation, the work consists mainly of twin-tunnels for each double-track line, the number of tracks ranging from two to six. This railway was described in *Engineering News-Record* of Aug. 25, 1927, p. 310.

Typical of the tunneling is the double-track line from the portal at Goulbourn St. to the Museum Station, which at one point passes under the corner of a large warehouse with a depth of 11 to 14 ft. to rail level. The greater part of this stretch has semicircular concrete roof arches of 15-ft. span, supported on side and center walls of brick masonry. The remainder has a flat roof of transverse I-beams 24 in. apart, resting on the three walls and embedded in a concrete slab. For the latter construction the clear width is 14 ft. 3 in. instead of 15 ft. One of the arch headings is shown in Fig. 1.

Starting from the Museum Station, three bottom headings 4 ft. wide were driven for the three tunnel walls. The outside headings were 10½ ft. high and the middle heading 12 ft. 9 in. high. These headings were timbered with squared sets, using 8x5-in. track ties for caps and 8x5-in. hardwood legs. The sets were close lathed on the roof and down the sides to the rock. They were driven 100 ft. before the bricklayers started on the walls.

The side walls were 32 in. thick and ended at the springing line. The middle wall, 24 in. thick, was carried up 27 in. above the springing line to give a 3-in. overhang or haunch on each side.

After the completion of the 100-ft. lengths of these walls, the excavation for the arched roofs was commenced. Instead of the usual form of timbering and crownbars, ribs of steel rails were used, as shown in Figs. 1 and 3. Centers 3 ft. apart were made up of four pieces of 80-lb. rails curved to the outside radius of the tunnel, and seated on bearing plates over the walls. When excavation of the arch had advanced 3 ft., another rib was erected. Hardwood bridging pieces about 30 in. long, cut to the radius of the curved rail, were blocked up, and hardwood pieces were driven on them from the top of the first rail set. Special care was taken to pack all cavities above the laths and to have all bolts tight.

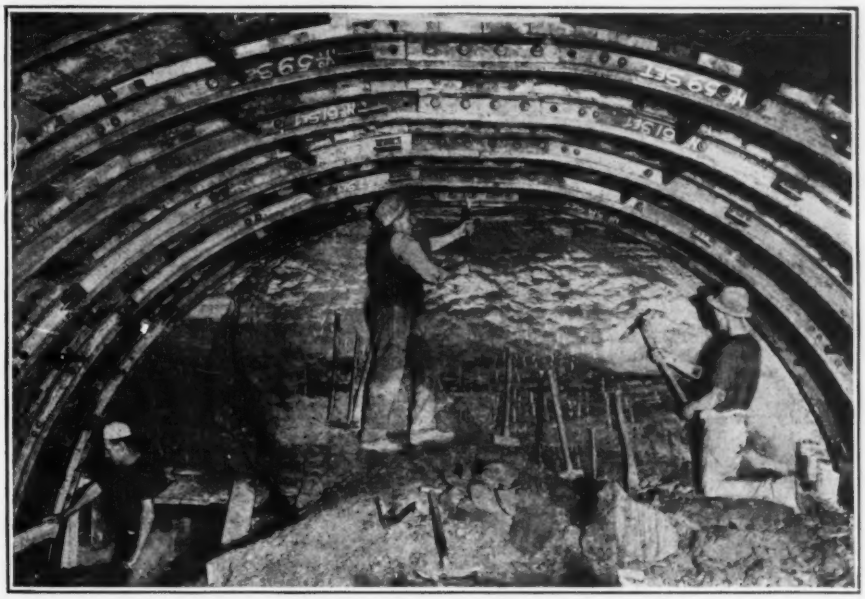


FIG. 1—DRIVING SUBWAY AT SYDNEY, AUSTRALIA
One side of twin tunnel. Steel arch ribs erected on side and center walls.

Following the first set, when some 18 in. of excavation had been removed in front of the rib, the laths were threaded under the bridging pieces and driven ahead as far as possible, the back ends being wedged down from the laths in the set behind. This maintained the ground above, while the next 18 in. was excavated and the rail or rib was placed. The laths and cap pieces in what had been the three wall headings were recovered as the driving of the arch proceeded, and the spoil from the arch portion was allowed to run down and fill the space between the walls and the sides of the headings. The balance of the spoil was filled into skips and run down to the portals to be disposed of by cranes and trucks.

After driving about 18 ft. of the heading, work was started on the concreting of a 12-ft. length of both arches, which averaged 18 in. thick. This was done without interfering with the excavation. Angle cleats with a ½-in. hole in each had been riveted to the webs of the ribs (see Figs. 1 and 3). From bolts put through these cleats were hung T-irons curved to a radius 3 in. less than the interior radius of the arch, and carrying 3-in. Oregon fir lagging on which the concrete was placed.

The two tunnels were concreted simultaneously, the

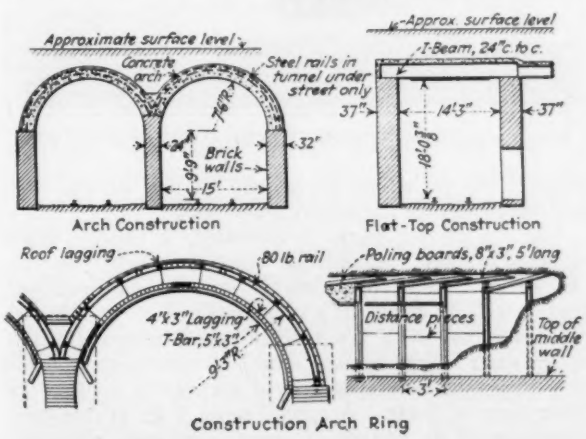


FIG. 2—TYPICAL TWIN-TUNNEL DESIGNS

concrete being mixed on the surface and conveyed by chutes into skips which were wheeled in and dumped onto a board. This concrete was then shoveled up into position above the lagging, the ribs and laths being left in place. The finished section of the tunnel was always maintained close behind the driving, thus giving the shale no chance of disintegrating through exposure to the air. As soon as the driving and concreting of the arches had been completed up to the end of the first section of the brick walls, the driving of the headings was recommenced and another 100 ft. of side walls was constructed.

Both tunnels were completed in this manner to the point at which the flat-top construction was to be commenced, but there still remained a dumpling of rock and shale about 10x10 ft. to be removed from each tunnel. There was also the loose shale and rock which had been allowed to run down from the arch into the headings after the brick walls were constructed. The solid material was broken up with compressed air hammers, though there were places where it was sufficiently hard to necessitate blasting. The ground surrounding the tunnels was then left practically in its original state. No damage was done to roads or buildings.

FIG. 3—TUNNEL ARCH COMPLETED
Forms for roof were suspended from steel ribs. Walls and arch finished. Dumpling removed later.

The railway was planned and built under the direction of J. J. C. Bradfield, chief engineer of the Metropolitan Railway; with R. J. Boyd as principal designing engineer; W. Farrow, supervisor of construction; and A. Humphries and K. A. Fraser, resident engineers.

Salaries in Building Departments

Figures of salaries paid the building departments of a number of cities are summarized in the accompanying table, as condensed from tabular records presented at the annual meeting of the Building Officials Conference:

Population	More than 1,000,000	500,000 to 1,000,000	100,000 to 500,000	Less than 100,000
Number of cities	5	8	37	32
Commissioner of Public Works	$5,000 to $8,000	$5,000 to $7,500	$2,200 to $7,500	$1,800 to $5,000
Department Commissioner	$3,000 to $6,300	$3,000 to $4,560	$2,000 to $4,500	$1,500 to $2,700
Engineer of Construction	$2,400 to $4,700	$2,600 to $4,200	$2,000 to $4,500	$2,280 to $3,600

The Au Deep-Well Current Meter for Locating Leaks

By Albert G. Fiedler
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Roswell, N. M.

ONE of the chief causes of the failure of artesian wells is the corrosion and resultant breaking down of the casing, thereby permitting the artesian water to percolate into permeable strata containing no water or water under a lower head. There is need for a reliable instrument to determine the location of leaks, particularly in old artesian wells which have failed and about which little information on their construction is available, this information showing whether a well could be successfully repaired or should be plugged and abandoned.

In the investigation of the artesian areas which the U. S. Geological Survey is called upon to study, definite information about the condition of the artesian wells is necessary in order that proper recommendations may be made for the conservation of this valuable natural resource. The current meters which have been used for this purpose have usually been adaptations of current meters used for measuring surface streams and have had limitations which have restricted their use. To overcome these limitations and provide an instrument which would not only detect and determine the location of the leak, but also measure approximately the quantity of water which was being lost, a new current meter was designed and constructed by C. H. Au, technician of the Water Resources Branch of the U. S. Geological Survey. This meter is being successfully used by the writer in an investigation of the Roswell artesian basin in the Pecos Valley of New Mexico.

The basic principle involved in the use of the meter is the same as that for current meters used in measuring surface streams, namely $q = a \times v$, where q equals the quantity of water passing the section, a equals the cross-section area, and v equals the velocity of the water passing the section. The current meter is used to determine the variations in velocity in the artesian well and thereby locate the underground leaks.

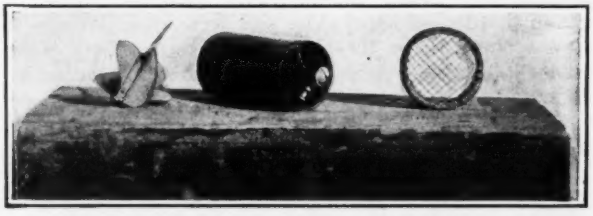


FIG. 1—TURBINE WHEEL, METER CASE AND SCREEN

The Au current meter is essentially a turbine wheel mounted within a cylindrical brass case which is suspended in a 3-in. pipe and is lowered and removed from a well by means of a cable and reel. Fig. 1 shows the brass case with the turbine wheel removed. The upper shaft of the turbine wheel is fitted with a single or penta-point commutator head such as is used in the Price current meter. A special cable, ¼ in. in diameter, consisting of six strands of seven wires each surrounding an insulated wire, is used to lower and raise the

meter in the well. By means of a telephone receiver and a small dry battery an electrical circuit is completed through the cable, which is connected to the commutator head, and the revolutions of the turbine wheel are determined in a manner similar to that in current meters used for measuring surface streams. The 3-in. pipe in which the meter is placed is made in two 4-ft. sections which can be connected by means of a collar. One section usually furnishes sufficient weight to carry the meter to the bottom of the hole. A screen, such as is shown in Fig. 1, is sometimes placed in the ends of the 3-in. pipe to prevent casing scale and gravel from obstructing the revolving turbine wheel. A measuring device consisting of a revolution counter attached to a grooved wheel, the circumference of which is 2 ft., is used to determine the distance the meter is raised or lowered.

The original equipment for raising and lowering the meter in the well was hand operated, but as a result of the experience gained in the field, the operating equipment was redesigned and constructed for mounting on a small truck as shown in Fig. 2. Power for removing the meter from the well is derived from the engine by means of a belt operated over a pulley on the rear wheel. The cable reel is provided with a commutator and brush through which the electrical circuit is completed and even while lowering or raising the meter in the well it is possible to know by means of the clicks in the

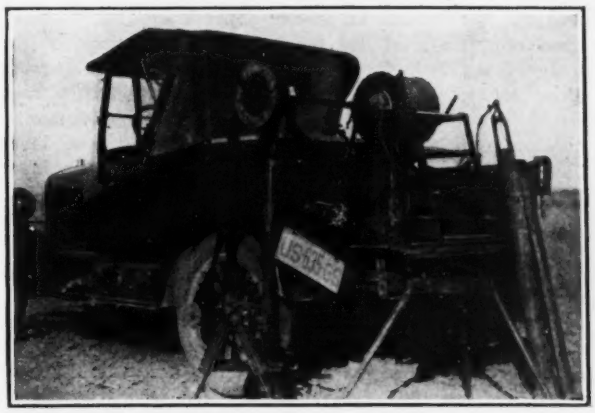


FIG. 2—AU METER EQUIPMENT READY FOR FIELD USE

headphone that the apparatus is operating satisfactorily.

The meter is rated by inserting it in a well, measuring the discharge with a weir or current meter, and timing the revolutions of the turbine wheel. Knowing the diameter of the casing and the discharge of the well, the mean velocity of the water, corresponding to the number of revolutions of the wheel, can readily be computed. Wells with different rates of discharge and different sizes of casing are rated in this manner and from the information obtained a velocity curve is drawn and a rating table computed.

In exploring a well, the meter is let down a little at a time and velocity observations are made at regular intervals to determine when a leak is passed. In a non-flowing well no velocity will be noted until a leak is encountered, while in a flowing well a leak is indicated by an increase in velocity. To guard against interpreting an increase in velocity as indicating a leak in a well that has been reduced in diameter, the discharge at the point where the diameter is known is computed and a like computation is made for the point of increased velocity using the next smaller regular size of hole or casing. If the computed discharges agree within reasonably close limits it is quite certain that the increase in velocity is due to a reduction in section.

The leaks usually occurring in wells are of four general types: (1) general disintegration of the casing, (2) one or more large leaks, (3) improperly seated casing, (4) insufficient casing. Each type of leak may be determined by a proper interpretation of the velocity observations. Fig. 3 shows the condition of casing in a well in the Roswell artesian basin in New Mexico. This well was examined with the current meter and the conditions found have been completely verified by the recasing work done on the well.

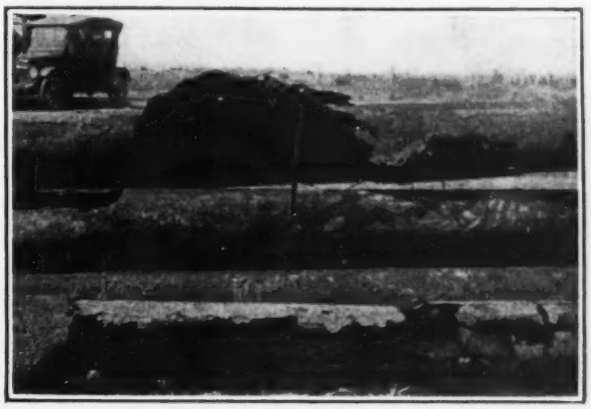


FIG. 3—DISINTEGRATED CASING FROM LEAKING WELL

Water Supply Emergency Ordinance Must Stand

An ordinance adopted by the city council of Fremont, Ohio, providing for a bond issue to construct a filtration plant must stand regardless of the fact that an initiated ordinance, calling for a driven well supply, was subsequently adopted by popular vote. This in substance is the effect of a decision of the Ohio Supreme Court announced May 11, 1927 (*State ex rel. Smith v. City of Fremont*, 157 N. E. 318). Under date of June 12, 1926, the Ohio Department of Health notified the city of Fremont that its water supply was impure and dangerous to health and ordered it to install a new supply or purification works. An ordinance providing for filtration was introduced June 15 and adopted June 29. On June 28 an initiative petition was filed with the city council calling for a supply from deep wells already owned by the city and such other wells as might be needed. This ordinance was adopted at a general election on Nov. 2. Meanwhile, on August 3, the city council passed an ordinance providing for the construction of a filtration plant and on Sept. 8 a contract for such a plant, in accordance with plans approved by the State Department of Health, was awarded. Mandamus proceedings were instituted to compel the city to drill wells and build accessory works. The court, with two justices dissenting, held that, since the first ordinance mentioned had been enacted as an emergency public health measure, there could be no referendum under the state constitution. The opinion indicated further that the proper action would have been to have applied for a referendum on the first ordinance instead of instituting proceedings for an initiative ordinance.

What Causes Corrugations in Traffic-Bound Roads?

Rain-Water and Wind Action Start the Chatter Bumps Which Motor Vehicle Traffic Develops Into a Nuisance

By J. P. McMakin
Civil and Highway Engineer, Catarina, Texas,
Formerly Construction Engineer, North Carolina
Highway Commission

MANY THEORIES have been advanced to account for corrugations or chatter-bumps in road surfaces of sand clay, gravel and chert. Attention is directed to the fact that in all these surfaces clay is the binding element. Top-soil, sand-clay, clay-gravel, clay-chert, virtually all traffic-bound types of road, develop chatter-bumps; and in all, clay is an essential ingredient. This emphasis is put on clay because of the close relation it has to the cause of chatter-bumps.

Getting directly to the subject, chatter-bumps appear to be spaced approximately 6 in. apart when one passes over them in an automobile. Actual measurements taken in different localities and on different classes of secondary type surfacing, proved them to be spaced, on an average, 2½ ft. from the center of one corrugation to the center of the succeeding one. Once in a while a depression was found to be 2 ft. 8 in. or 3 ft. distant from the next one, but these cases were seldom encountered. On comparatively level grades the transverse corrugations are practically at right angles to the center line of the roadway, and on grades they are at angles to the center line of the roadway, the degree of this angle being governed largely by the steepness of the grade. The distance of the spacing of corrugations was measured at right angles to their alignment.

Investigation of Causes—This uniform spacing of the depressions led to close investigation for a natural cause, rather than for an artificial one such as automobile wheels, chattering road machines, road drags and maintainers that vibrate at times as they pass over the surface of clay-gravel roads in particular, and top-soil roads where the material contains stones or gravel. This vibration does not occur frequently on sand-clay roads until after corrugations have begun to form.

The investigation was made by dissecting the contents of the depressions—beginning on the surface and scraping away horizontal shallow films of the material for several inches below the surface. It was found that the top layer was composed of a loose sand, which was of a varying gradation in most cases. Immediately beneath this was a fairly compacted and only slightly-bonded layer of porous sand and the coarser and least soluble particles of clay, the clay content being low. Below this was a slightly denser mass containing a higher percentage of the fine clay-filler material, each succeeding layer being more dense than the previous one. There were no well-defined layers of the varying degrees of density, but they appeared to blend gradually into one another.

Rain-water—So far we have found a variation in the density and compactness of the roadway surfacing at regular intervals. There must be a cause for this character of disintegration in a surface in which great care was used in selecting properly-graded materials, and where the correct amount of mixing, shaping and finishing was done. The next question naturally is: What is the cause? The investigation was continued along the lines of the lateral extent of corrugations transversely to the roadway and it was found that within a foot or two of the crown of the road the depressions were very shallow. Also, their depth increased as the per cent of grade of crown increased towards the side of the road. On close inspection slight diagonal depressions could be detected along and near the center line or the top of the crown. These depressions led into the transverse chatter-bumps and the whole layout of a chatter-bump depression had the same general appearance, in a miniature way, as that of small washes that occur at the headings of gullies and arroyos in fields and hilly country and that are caused by erosion. The action of flowing storm-water carries away part of the land over which it flows and leaves gullies of increasing size as the water advances and as additional water flows into the same collecting depressions. In a flat field that has a slope but one way, there occur washes spaced quite regularly, and each wash and gully has its own small washes radiating from it.

At this point of the investigation the weather was dry, but from all indications there entered into this disintegration of portions of the road one of nature's elements, namely, rain-water. It was apparent from the texture of the material in the depressions that some of the binder material had been taken out, as most of the material remaining was clear sand. This led to a search along the side ditches, where it was found that a high percentage of deposit was composed of fine particles, clay predominating, which lay at the bottom of each layer of material deposited by successive rains, the top layer being composed of sand in varying gradation.

Later, during rainfall, it was noticed that as the rain fell the water did not remain uniformly distributed but collected at regular intervals into streamlets which trickled to the side ditches from the crown of the road, causing small gullies. On its arrival in the side ditches, the water was quite muddy, but did not seem to be carrying any appreciable amount of surfacing material with it. This was easily accounted for when the exceptional fineness of clay was considered. The binder, clay, was being taken out of the surfacing material by the action of the rain-water, leaving the coarser aggregate, sand, with no stabilizing agent. Naturally, this sand, as soon as it was dry, would be whipped out of the small transverse water channels by the suction of the wind and wheels, and slight depressions would be left that increase in size and are so very noticeable to automobile traffic.

Wind Action—Before taking up further the question of chatter-bumps, let us consider the results of the action of the elements along the seashores, on sand dunes, and in the world's famous sand deserts. On all of these are found corrugations occurring at regular intervals which are similar to chatter-bumps. Here there is no bonding agent, and the winds pick up small particles of sand and carry them along until they come in contact with slight irregularities in the surface, and there they lodge. Many thousands of these small grains, lodging one upon another at comparatively regular intervals, form corrugations over vast expanses of desert and seashore. The only appreciable difference between these irregularities and chatter-bumps is that the former occur-

where there is no traffic, while the latter occur where there is traffic, demonstrating that traffic is not an essential requisite in the formation of chatter-bumps.

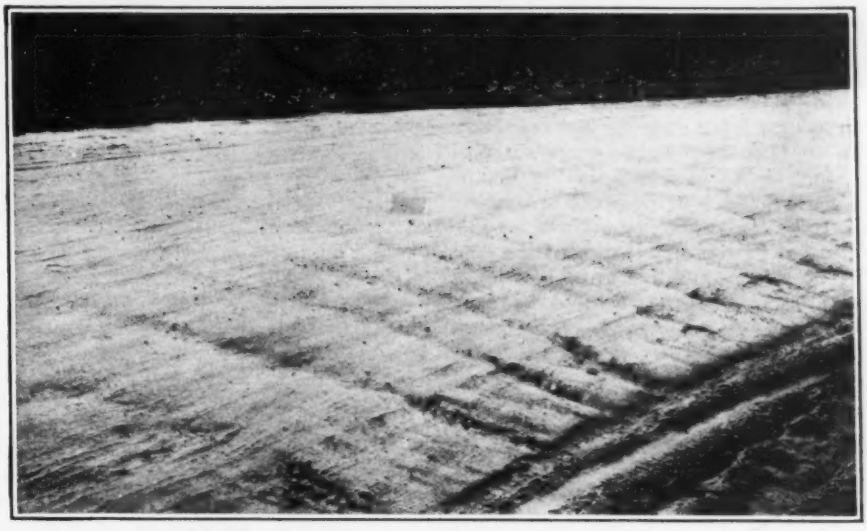
On sand-clay roads water causes the primary damage, which wind, both natural and artificial, aggravates by pulling the loose sand out of the depressions, carrying it along, and depositing it at regular intervals. This sequence helps to build up the high spots of the chatter-bumps.

In the cases of the clay-gravel, top-soil, and similar roads, it will be remembered that these types of surfacing contain a certain proportion of the clay binder. They will, therefore, be affected by rain-water similarly to the sand-clay roads. On the other hand, the absence of rain does not prevent the chatter-bumps from forming, for there is still that other agent of destruction, wind, to be reckoned with. The wind picks up small particles of sand and propels them along, causing then to come in contact with the roadway and dislodge other particles of sand. This action gradually accomplishes the feat of wearing away a sufficient quantity of material for it to begin lodging on the surface at intervals, causing corrugations to form similar to the irregularities on the deserts and sand dunes.

Artificial Agencies—The texture of clay-gravel, topsoil and similar surfacings is different from that of the sand-clay, in that it contains gravel or pieces of stone in varying sizes and shapes; while the sand-clay surfacing material contains no particles larger than those of sand. The former is more quickly affected by the artificial agents of destruction than is the latter. Motor vehicle tires, such as vacuum cup, non-skid and rough tread pneumatic, also broad and flat treads, cause terrific suction on the surface of these roads. This suction on and rasping of the roadway surface dislodges particles of gravel, small stones and sand. The wind, caused by the velocity of vehicles, draws these dislodged particles along the surface, acting as a medium of mobility for the suspended particles—similar to its action on desert and seashore. Thus the fine material piles up until a very appreciable high spot is caused. When these chatter-bumps have begun forming, their depth increases very rapidly. They are similar in formation to those that appear in sand-clay roads.

Wheel Action—This condition is greatly aggravated by the emery-wheel action of the wheels of power-driven vehicles that occurs when a vertical motion is set up in these wheels when passing over slight corrugations. It is a well-known fact that when road irregularities cause a power-driven wheel to leave the traction surface and revolve in space, it revolves many times faster than it does when in contact with the speed-controlling resistance of the road. When the same wheel again comes in contact with the road, the action is similar to that of a circular saw and a portion of the surfacing is dislodged and kicked from any spot which it happens to strike either high or low—that is, from either the summits of the chatter-bumps or from the depressions. Some of this dislodged material falls loosely in the rear. The distance it is thrown depends, of course, upon the speed of the vehicle. It is then drawn forward by the next oncoming machine. The rest of this dislodged material remains in suspension in the suction of air following the vehicle that stirred it up, until it is deposited in other spots, much the same as the sands of the deserts are deposited in regular corrugations.

The surface of the road where the sucked-up material is first deposited is somewhat protected by this addition from further damage by revolving wheels; while the portions of the surfacing between these higher and protected spots are left subject to further wear. Thus the depressions continually become deeper, while the high spots either hold their own or are built up higher—and the longer this condition is allowed to exist, the more noticeable become the chatter-bumps as a car passes over them.



A TYPICAL EXAMPLE OF ADVANCED ROAD CORRUGATION

The writer has attempted to show—after a number of years of close observation and investigation—why chatter-bumps come in the surfacing of our secondary types of roads; and how their evolution is the direct result of the action of the natural elements of destruction on the natural elements used in the construction of these roads. It has not been feasible to enumerate separately the almost countless steps which go into the making up of the evolution of a chatter-bump, as the developments consists of a chain of physical changes which blend into one another so gradually as to be imperceptible.

Maintenance—In recent years, as the result of much attention, study, and invention of machines, big strides have been made along the lines of efficiency in maintenance. We have not, however, succeeded in finding machines or methods of manipulating the materials which will prevent chatter-bumps from forming or will permanently remove them. The lighter types of machines, such as road drags and road maintainers, make the surface appear to be in good shape immediately after they have passed over it. But they merely pull a light coating of the unaffected material over the disintegrated material which remains in the depressions, or they fill the depressions with loose material that has been scraped from the

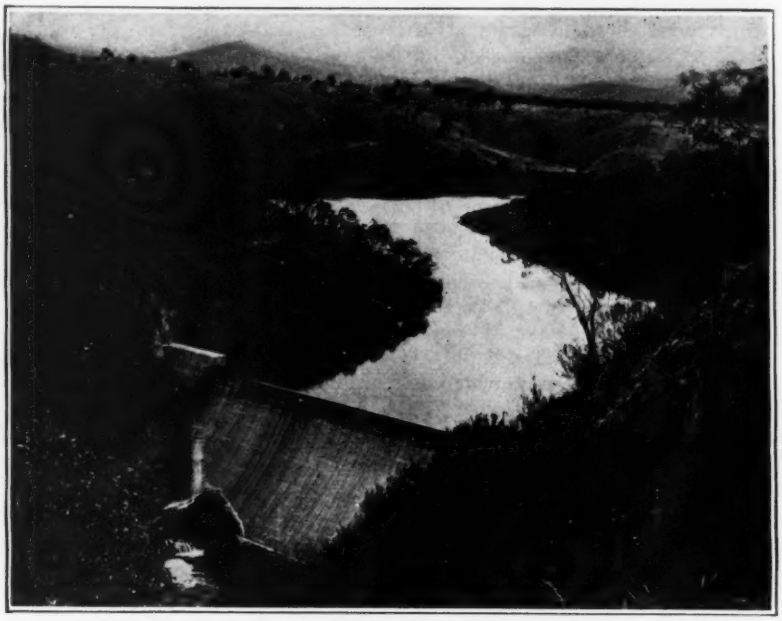
solid portions of the road. This material does not become compacted to the same extent as that material which composes the rest of the surface. The chatter-bumps are merely temporarily hidden and will soon make their appearance again, for they have not been permanently repaired. This sequence of operations is continued almost indefinitely, each time the chatter-bumps showing up in a little farther advanced stage. In many instances, the chatter-bumps have been allowed to become so deep that it is necessary to scarify the entire surface, bring in additional material, and practically rebuild the road —which is a very costly operation.

In the description of the formation of chatter-bumps it has been shown that their growth is relatively slow. Therefore, if maintenance is started immediately on completion of construction with this fact in mind, the little chatter-bumps will more effectually be prevented from growing into big ones. In order to do this, the whole surface should be scarified to a shallow depth when weather conditions are favorable, and the small corrugations will be obliterated by the disturbance of the entire surface. For this to be economically accomplished, it would be necessary to slightly scarify coincidently with every operation of the road drags. When again compacted there will be no corrugations left.

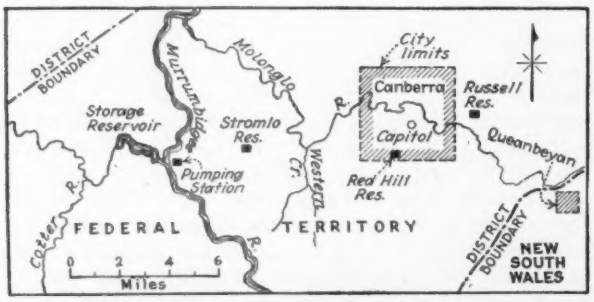
Water Supply and Sewerage for New Australian Capital

Electric-Driven Centrifugal Pumps Lift Impounded Water Total of 840 Ft.—Activated-Sludge Included in Sewage-Works

FOR the newly built capital city of Australia, named Canberra, which was formally opened in May, 1927, the water supply is obtained from a storage reservoir on the Cotter River about 15 miles from the city. This stream, a tributary of the Murrumbidgee, has an average flow of 70 m.g.d. The water is of good quality and there is no fear of future contamination, as the drainage area of the river 170 sq.mi., is in rough country, entirely within the Federal Territory, so that it is subject to control by the federal government. A 60-ft. dam forms a 380-m.g. reservoir with a safe yield of 7 m.g.d. The dam is designed for a future height of 100 ft., to give 1,400 m.g. storage capacity.



COTTER RIVER DAM AND RESERVOIR



WATER SUPPLY SYSTEM OF CANBERRA

From the reservoir an 18-in. cast-iron main 4,100 ft. long is laid in a tunnel under the Murrumbidgee River and then to a pumping station from which an 18-in. force main 3½ miles long extends to a 3-m.g. service reservoir on Mount Stromlo. A gravity main of the same size connects this reservoir with another service reservoir of the same capacity on Red Hill. A third service reservoir of 1-m.g. capacity (which can be increased to 3-m.g.) provides for the northern part of the city, including the military college. At the pumping station there are two direct electric-driven centrifugal pumps, each with a capacity of 2.4 m.g. against the 840-ft. head of the Mount Stromlo reservoir. Current is supplied from the central power plant at Canberra.

A gravity supply system was proposed, but it was decided that its great cost would not be warranted until the population exceeds 50,000—at present it is about 5,000. Meanwhile the annual expense for pumping is said to be considerably less than the interest on the cost of a gravity system. Alternative mains from the different reservoirs have been provided to ensure an uninterrupted supply. A distribution system of 25 miles has been laid, the minimum pipe diameter being 4 in.

Sewage-works have been provided, with effluent discharge into Western Creek. As no stream pollution was permissible, these works include settling tanks and filters and an activated-sludge unit, so that experience will indicate what system should be employed in the future. There are three intercepting sewers: a 30-in. northern sewer two miles long and a 21-in. southern sewer of the same length converge upon a 66 x 44-in. oval sewer two miles long, which serves the central part of the city. This last connects with an outfall sewer of the same section, extending three miles to the treatment works at Western Creek.

Colonel P. T. Owen, chief engineer of the Federal Capital Commission, has had charge of construction.

Revaluation of Denver Buildings for Tax Assessment

Cubic Foot Costs Established for Poor, Average and Good Condition for 27 Standard Types—School for Assessors

By W. L. Prouty

Consulting Valuation Engineer, Department of Revenue, Denver, Colo.; Senior Member of Prouty Brothers Engineering Co., Denver, Colo.

SHORTLY after being appointed to the office of manager of revenue of the City and County of Denver, Clem W. Collins found that the "guess" system of making property appraisals for purposes of taxation which had long been in use in Denver and other large American cities, had given rise to an unjust distribution of the tax burden upon the taxpayers of the city. Some properties were either grossly underassessed or overassessed. To remedy these conditions Mr. Collins decided not only to establish a systematic method of valuation procedure which would justly equalize the burden of taxes but also to conduct an educational campaign. The latter will be described before taking up the revaluation procedure.

The writer, who for several years past had been instructor of a class in plan reading and estimating in the Evening Vocational High School, was requested by Mr. Collins and the Denver School Board to become instructor to an assessors' class, composed largely of employees of Mr. Collins' office, together with bankers, realtors and business men. A two-year course of instruction was given, including a detailed study of plan reading and estimating, building materials, building labor, building costs, surveys and subdivisions, the slide rule, valuations and appraisals, depreciation and appreciation, obsolescence, tax laws, legal opinions, duties of the assessor, growth of cities, assessing as a vocation, land values, cubic foot costs of buildings, methods used in other cities, life and depreciation of buildings, special improvement taxes, personality taxes, the assessor's calendar, the real estate record card, history of taxation, financing government, appraisal of machinery, taxable investments, use of tables and charts, the Denver Assessors Manual, building cost over a period of years, comparison of Denver and Colorado with other cities and states in matters of taxation, and history of assessments in Denver.

The course of study was supplemented by lectures given by some of Denver's best known business and professional men on subjects similar to the foregoing outline of topics. These lectures brought to the class

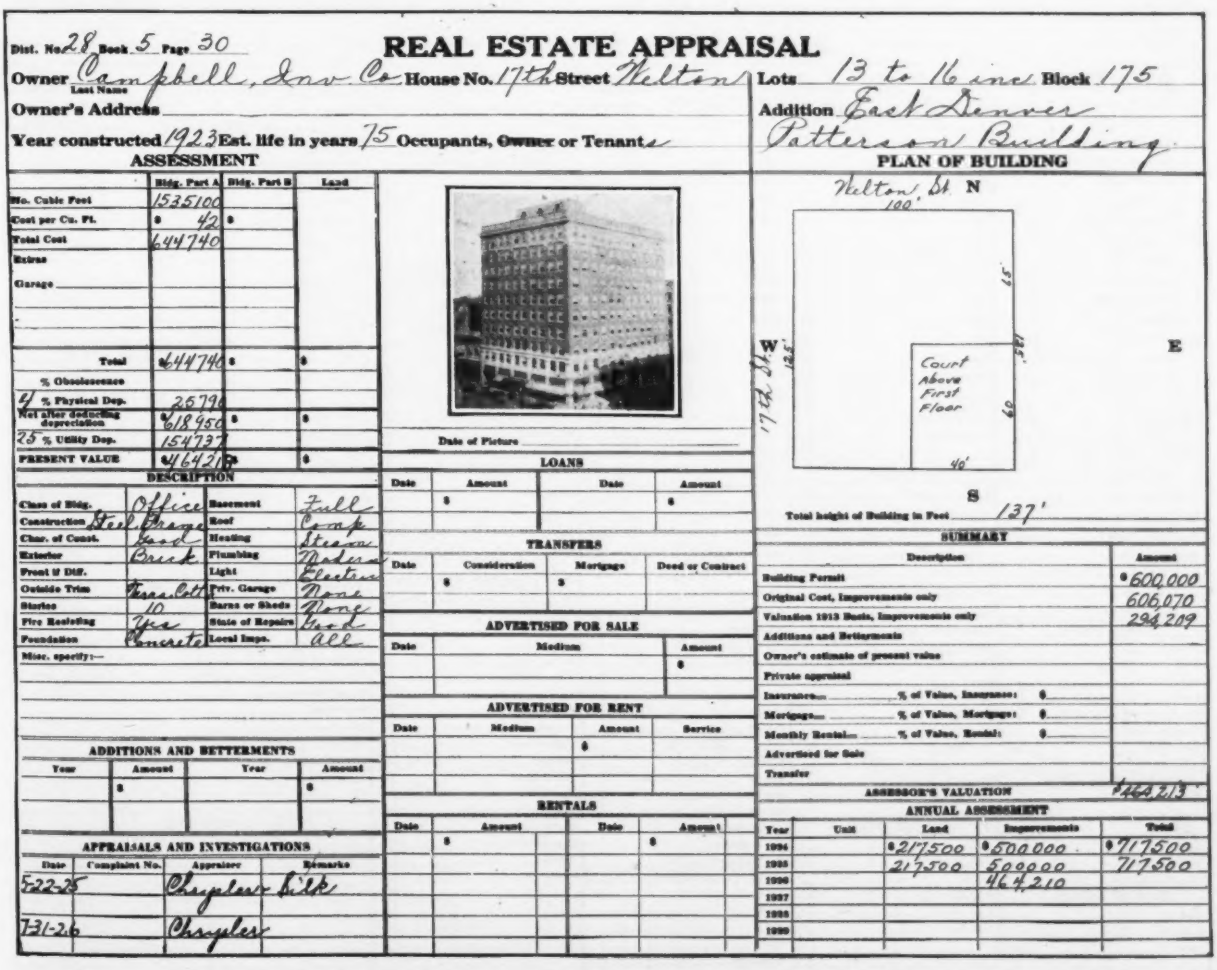


FIG. 1—FACE OF BUILDING TAXATION ASSESSMENT BLANK USED AT DENVER
Original sheet 12 in. wide and 9½ in. high.

a broad knowledge of factors entering into the valuation of property from acknowledged experts who were willing to assist in every possible way and who spoke freely out of the wealth of their own experience. Among the speakers were engineers, architects, contractors, bankers, realtors, building material supply dealers, appraisers, furniture dealers, university professors, the city building inspector, and federal, state and city taxing officials. So far as known this is the first assessors' class ever held in the United States.

Coming now to revaluation procedure: A real estate record card (Figs. 1 and 2) is filled out for every building. The photograph is attached to the card in the space shown, and a floor plan of the building is drawn. All information which may have a bearing on the established value of the building is given, such as building permits, additions and betterments, appraisals, loans, transfers, advertisements for sale or for rent, rentals, original cost, owner's estimate of value, insurance, mortgages, etc. A reproduction cost is established from which deductions for physical and obsolescent depreciation are made. All costs are referred to a 1913 basis of 100. After making a thorough study of all available information on the life and depreciation of buildings the Denver life and depreciation table was compiled. The straight line formula was used for figuring depreciation.

All building costs were estimated on the cubic foot basis in preference to the square foot basis for the following reasons: (1) It takes account of the height of a building and the variation in height of the different parts of a building. (2) It considers every part of the building more in detail than the square foot method, such as porches, sunrooms, attic space, basements, etc. (3) It considers different types of roof construction.

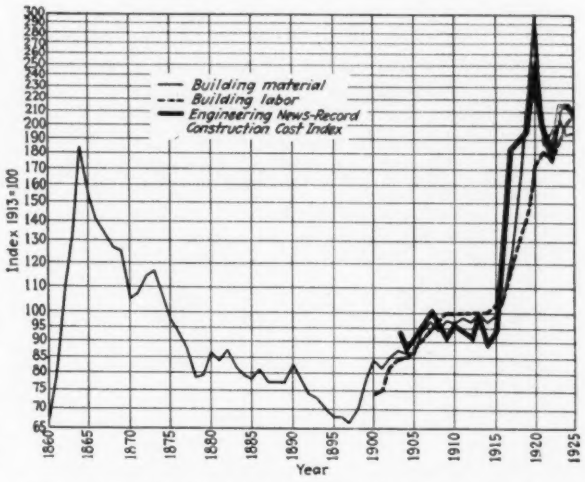


FIG. 3—DENVER BUILDING COST DIAGRAM, 1860 to 1925

CLASS OF BUILDING (Check)
1—Single Residence
2—Double Residence
3—Two Family Residence
4—Bungalow Apts. or Court
5—Flat or Terrace
6—Tenement
7—Apartment House
8—Apartment Hotel
9—Hotel
10—Store Building ✓
11—Department Store Building
12—Office Building ✓
13—Orphanage
14—Hospital or Sanitarium
15—Bank Building
16—Theatre
17—Church
18—Public Building
19—Fraternal Building
20—Warehouse
21—Factory
22—Public Garage
23—Private Garage
24—Service Station
25—Hot House or Green House
26—Poultry House
27—Barns or Sheds

CONSTRUCTION
Frame
Brick
Tile
Stone
Concrete, Plain or Block
Concrete, Reinforced
Steel Frame F-2 ✓

CHARACTER OF CONST.
Cheap
Medium
Good ✓
Special
Fire Resisting ✓
Non-Fire Resisting

STATE OF REPAIRS
Bad
Fair
Good ✓

HEIGHT (Check)
No. of Stories 10 ✓

FOUNDATION
Brick
Concrete ✓
Stone
Wood
Tile
Posts

BASEMENT
Cellar
Half
Quarter
Full ✓
Cement Floor ✓
Finished Walls and Ceiling
Laundry
Ball or Billiard Room
Storage Space

EXTERIOR
Common Brick
Pressed Brick ✓
Wire Cut Brick
Glazed Brick
Wood Siding
Wood Shingles
Cement Stucco
Estimate
Stone
Corrugated Iron
Paper
Adobe
Terra Cotta ✓
Marble
Travertin
Tile
Plaster
Plate Glass

OUTSIDE TRIM
Wood
Terra Cotta ✓
Stone
Travertin
Galv. Iron
Concrete

ROOF (Check)
CONSTRUCTION
Wood Shingle
Composition Shingle
Tar and Gravel
Prepared Paper ✓
Sheet Iron
Copper
Concrete Tile
Clay Tile
Slate
Asbestos Shingle
Tin

STYLE
Gable
Hip
Flat ✓
Gambrel
Mansard
Leanto

PLUMBING
Old Style
Modern ✓
No. Bath Tubs
No. Shower Baths
No. Toilets
No. Lavatories
No. Urinals
No. Laundry Tubs
No. Sinks
Swimming Pool
Sanitary Closet
Well
Cess Pool

HEATING
Stove
Hot Air
Hot Water
Steam ✓
Central Station
No. Fireplaces
No. Dummy Fireplaces

FUEL
Coal ✓
Wood
Oil
Gas
Electricity

LIGHT (Check)
Electric ✓
Gas
Oil

PRIVATE GARAGE
Size
Construction
Floor
Roof
Heat

SHEDS AND BARNS
Size Const.
Size Const.

LOCAL IMPROVEMENTS (Check)
Street Grading
Street Paving (Macadam)
Street Paving (Asphalt) ✓
Alley Paving ✓
Sidewalks ✓
Curbing ✓
Water ✓
Storm Sewer ✓
Sanitary Sewer ✓
Electricity ✓
Gas ✓
Telephone ✓

MISCELLANEOUS (Give No.)
Sideboards
Buffet
Cabinet
Book Cases
Beam Ceiling
Sprinkler System
Incinerator
Vacuum Cleaning System
Patent Beds
Elevators, Kind 5 electric ✓
Fire Escapes ✓
Sky Lights ✓
Refrigerator or Cooler
Bay Windows
Dormer Windows
Porches
Fences

DESCRIPTION (Give Numbers)

ROOMS	STORIES Base'm't	1	2	3	4 Flr.	Attic
Living Room						
Dining Room						
Bed Room						
Kitchen						
Bath Room						
Toilet Room		2	1	2	9	
Shower Room						
Sleeping Porch						
Sun Room						
Observatory						
Halls						
Office			15	15	105	
Storage Room	4					
Stores		7				
Breakfast Nook						
Boiler Coal	1					
Engine	1					
Boiler	1					

FINISH (Give Numbers)

Unfinished						
Plastered, plain	—	—	all	—	—	—
Plastered, ornam.						
Papered						
Painted or Tinted	—	—	all	—	—	—
Softwood floor						
Hardwood floor						
Softwood finish						
Hardwood finish						
Tile floors			Hall + toilets			
Marble or Onyx						
Wall Board						
Sheetrock						
Celotex						
Wainscoting						
Metal Ceiling						
Cement	—	—	all	—	—	—

REMARKS

FIG. 2—BACK OF BUILDING ASSESSMENT BLANK USED AT DENVER

(4) It is more generally used and produces more accurate results than the square foot method.

Building costs from many sources were tabulated, the costs being referred to a 1925 base, using 1913 equal to 100. From this tabulated information, cubic foot costs were established for poor, average and good construction buildings for the standard types listed in the 27 classifications. Each standard type of building is described in the following ways: (1) Number of stories. (2) Size of basement. (3) Basement floor. (4) Basement finish. (5) Foundation walls. (6) Wall construction and interior finish. (7) Porches. (8) Roof. (9) Floors. (10) Heating. (11) Plumbing. (12) Built-in features. (13) Fire-resisting qualities. Any deductions from or additions to the standard buildings are figured from a list of unit prices covering such deductions or additions.

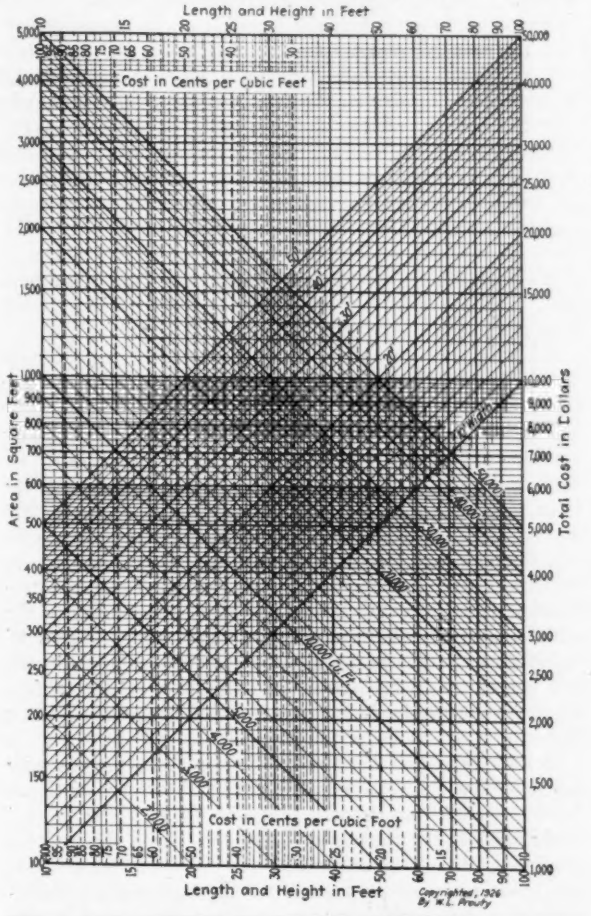

Length and Height in Feet
Cost in Cents per Cubic Feet
Area in Square Feet
Total Cost in Dollars
Cost in Cents per Cubic Foot
Length and Height in Feet
Copyrighted, 1926 By W. L. Prouty

FIG. 4—LOGARITHMIC CHART FOR COMPUTING BUILDING VALUES FOR TAXATION

Designed for Denver Assessor's Manual by W. L. Prouty. Chart copyrighted in 1926 by W. L. Prouty. The original chart is 18 in. high by 12 in. wide. The manual contains a second chart, covering lengths and heights of 10 to 150 ft. areas of 1,000 to 13,000 sq.ft. and values of from $10,000 to $100,000.

EXAMPLE OF USE. What is the value of a five-room brick residence where the length is 40 ft., width 24 ft., height 20 ft. and the cost per cubic foot 28c.? Enter the chart at either top or bottom for a length of 40 ft. Follow this vertical line to where it intersects the diagonal line for width equal 24 ft. The area, 960 sq.ft. is read on the left hand margin of the chart. Retrace same horizontal line to intersect vertical line reading from either top or bottom for height of 20 ft. and the diagonal cubic foot line reads 19,200. Follow this line parallel with the cubic foot lines to intersect the vertical dash line 28c. per cu.ft., read at the bottom of chart. Follow the horizontal line intersected to the right margin and read total cost of building equals $5,376.

It was found necessary to establish a Denver building cost chart with 1913 costs equal to a basis of 100. Charts published by professional organizations, private corporations and technical publications were found to be unsatisfactory as applied to Denver for two reasons: (1) Fluctuations in cost of materials and labor are greater in far eastern and far western cities than in Denver. (2) The weights of influence for the cost of various building materials and labor used in constructing the charts does not conform to the actual conditions existing in Denver.

DENVER BUILDING LIFE AND DEPRECIATION TABLE

Classification	Poor Construction Life Years	Poor Construction Annual Dep'n, Per Cent	Average Construction Life Years	Average Construction Annual Dep'n, Per Cent	Good Construction Life Years	Good Construction Annual Dep'n, Per Cent
(1) Single residence						
Frame A	20	5.0	25	4.0	30	3.3
Frame B	30	3.3	35	2.9	40	2.5
Frame C	40	2.5	50	2.0	50	1.7
Frame D	30	3.3	40	2.5	50	2.0
Brick A	30	3.3	40	2.5	50	2.0
Brick B	50	2.0	55	1.8	65	1.5
Brick C	65	1.5	70	1.4	80	1.25
Brick D	80	1.25	90	1.1	100	1.0
Brick E	50	2.0	55	1.8	65	1.5
Brick F	50	2.0	55	1.8	65	1.5
Stone A	80	1.25	100	1.0	1.20	.8
(2) Double residence						
Frame A	25	4.0	30	3.3	30	3.3
Brick A	25	4.0	30	3.3	30	3.3
Brick B	30	3.3	40	2.5	50	2.0
Brick C	50	2.0	55	1.8	65	1.5
Brick D	40	2.5	50	2.0	55	1.8
(3) Two-family residence						
Frame A	25	4.0	30	3.3	40	2.5
Brick A	40	2.5	50	2.0	55	1.8
(4) Bungalow Apts. and Court						
Brick A	50	2.0	55	1.8	65	1.5
(5) Flat or terrace						
Brick A	25	4.0	30	3.3	40	2.5
Brick B	30	3.3	40	2.5	50	2.0
(6) Tenement						
Brick A	30	3.3	40	2.5	50	2.0
(7) Apartment house						
Brick A	40	2.5	50	2.0	55	1.8
Brick B	55	1.8	70	1.4	80	1.25
(8) Apartment hotel						
Brick A	50	2.0	55	1.8	65	1.5
(9) Hotel						
Brick A	40	2.5	50	2.0	55	1.8
Brick B	55	1.8	65	1.5	70	1.4
Brick C	80	1.25	90	1.1	100	1.0
(10) Store						
Frame A	25	4.0	30	3.3	30	3.3
Brick A	25	4.0	30	3.3	30	3.3
Brick B	30	3.3	40	2.5	50	2.0
Brick C	40	2.5	50	2.0	55	1.8
Brick D	40	2.5	50	2.0	55	1.8
(11) Department store						
Brick A	40	2.5	55	1.8	70	1.4
(12) Office building						
(13) Orphanage						
Brick A	40	2.5	60	1.7	80	1.25
(14) Hospital or sanatorium						
Brick A	40	2.5	60	1.7	80	1.25
(15) Bank building						
Brick store or Terra cotta	65	1.5	80	1.25	100	1.0
(16) Theatre						
(17) Church						
Frame A	20	5.0	25	4.0	30	3.3
Brick A	25	4.0	30	3.3	40	2.5
Brick B	50	2.0	55	1.8	65	1.5
Stone A	80	1.25	100	1.0	120	.83
(18) Public building						
Brick or stone	80	1.25	100	1.0	120	.83
(19) Fraternal building						
Brick A	50	2.0	55	1.8	65	1.5
Stone A	80	1.25	100	1.0	120	.83
(20) Warehouse						
Brick A	25	4.0	30	3.3	40	2.5
Brick B	50	2.0	55	1.8	65	1.5
Brick C	65	1.5	70	1.4	80	1.25
(21) Factory						
Brick A	20	5.0	25	4.0	30	3.3
Brick B	30	3.3	40	2.5	50	2.0
Brick C	40	2.5	50	2.0	55	1.8
Brick D	40	2.5	50	2.0	55	1.8
(22) Public garage						
Brick A	20	5.0	25	4.0	30	3.3
Brick B	30	3.3	40	2.5	50	2.0
Brick C	40	2.5	50	2.0	55	1.8
Brick D	50	2.0	55	1.8	65	1.5
(23) Private						
Brick A	25	4.0	30	3.3	40	2.5
(24) Service station						
Brick A	25	4.0	30	3.3	40	2.5
Terra cotta A	50	2.0	55	1.8	65	1.5
(25) Hothouse and Greenhouse						
Glass A	...	....	10	10.0	...	....
(26) Poultry house	Information not required					
(27) Barns and sheds	Information not required					

Cost data on building materials from 1900 to 1925 were obtained from local manufacturers and dealers, while for labor costs over the same period data were obtained from the union labor organizations and the Colorado State Department of Labor. Each factor of labor and material entering into frame, brick, and steel-skeleton buildings was given its relative weight of influence in determining the cost of a structure as established by actual construction experience. The final cost index for each year was arrived at by multiplying the cost index of each factor by its weight of influence and adding the factors thus obtained which equals the Cost Factor Index. The yearly indices thus obtained make a truthful comparison of actual existing conditions applicable to Denver.

A logarithmic chart has been prepared and copyrighted by the writer from which the total cost of a building can be determined directly without mathematical or mechanical computation, for any size of building for which the width, length, height and cost per cubic foot are given. A manual has been prepared for the use of those engaged in the work and has been found to be very helpful. A staff of from 30 to 50 men has been employed. The approximate cost of revaluing 65,000 parcels of property, including both field and office work, was $85,000.

An Engineer's Comments

On Greece

By C. E. Grunsky
Consulting Engineer, San Francisco, Calif.

TO THE American who is all too apt to arrive in Greece with unpleasant expectations as to the country and to the modern Greek, Athens is a pleasant surprise. This is particularly true if the arrival is from the East, because in that event the European aspect and cleanliness, as well as the street work now under way and the wholesome friendly mien of the people, are in strong contrast with the more foreign and less appealing ways of the Arabic peoples.

To those familiar with the American West and with the frontier problems which confronted the pioneer, it is an impressive fact that vast areas of agricultural land in Greece have been used throughout ages for pasturage. Similar conditions to those which have so rapidly been modified in the West by the venturesome settler still obtain here, where engineering activity has been almost unknown. The highways and roads have had no care. Many are not worthy of the name, being hardly better than pioneer wagon tracks. In all directions, there is work for the engineer.

To illustrate what a field Greece is for the engineer, it is only necessary to recall that at Athens, until quite recently, the population, swelled a few years ago by the influx of refugees to about 1,000,000, was getting along on a water supply of only 1½ gal. per capita per day. By the enlargement of the old Hadrian aqueduct and the prevention of loss by leakage, the supply has now been increased. It is hoped that by drawing upon a number of the available underground sources a volume can be secured which will supply the population for four or five years, when the new water-supply project, being built under contract by the American firm of Ulen & Co., will be completed.

The site is being stripped for the storage dam, which is to impound the runoff from an area of about 180 sq.km. (70 sq.mi.) on which the normal annual rainfall is about 25 in. The only available rainfall record in the vicinity is that at Athens, which shows about 20 in. annually during the last 50 years. A tunnel through the mountain range which separates Marathon from the plains of Athens, is being driven from both ends. Concrete blocks for the lining, which it is expected will be required throughout the entire 13 km. of tunnel, are being cast and held in readiness for the lining work which is soon to begin. It is no little satisfaction to know that about eighteen Americans are employed on this work. The staff of resident engineers is headed by R. H. Keays as chief engineer. Government bonds were taken in payment for the construction work, which indicates that American capital has made the project possible.

This is not, however, the only engineering activity with which American engineers are connected. Greece has actually begun the reclamation of marsh areas near Salonika. The first work on a large scale is now being carried out by the Foundation Co. The importance of such reclamation is clear when it is realized that there is in Greece a total marshland area of about 1,000,000 acres. This does not include large additional areas of lakes which can be drained nor the areas subject to periodical overflow by river floods. The Refuge Commission, in referring to a condition occurring in the middle of July, 1925, says: "On the very outskirts of Salonika . . . communications are broken and men and beasts travel on plaves (a kind of raft); at a few kilometers from the Macedonian capital the great Egnatia highway is over-run by the rush of water."

It is understood that the work already in progress by the Foundation Co., involving the draining of lakes Ardjan and Amatavo, will make about 25,000 acres of land available for cultivation. Quoting the Refuge Commission: "Wherever the possibility has presented itself, our colonizing services have undertaken certain indispensable work—embankment work on the Axios, drainage and irrigation in the Karadjova, on the right bank of the Strymon at Sidirocastron. Special mention should be made of the embankment work on the Serres plain, also on a branch of the Strymon, and along the Belitza; also of canal dredging and weirs affecting 20 villages (3,000 families). . . . In Epirus, drainage work has benefited 6 villages and has restored to agriculture 15,000 stremmas (about 3,400 acres) of what was formerly flood land. . . . There is already a shortage of land. Helped by the rapid rise in the birth rate, the agricultural refugee population will in a generation or two have largely increased. Hence, unless the drainage work has been completed, Greece will have to face the problem of an agricultural proletariat and a movement towards the towns, without the surplus population from the country."

The extensive and new activity of the housing and settling on land of more than 1,000,000 people within two or three years has brought to Greece all the incident problems of transportation, road building and sanitation. The new settlers come as pioneers who have been made to realize that it is possible to get out of the ruts of tradition and to fit themselves into new surroundings. What this means for Greece the next decades will show. The outlook is bright.

A Series of Eight Articles on

Winter Construction Methods and Plant

BY C. S. HILL
Associate Editor, Engineering News-Record

1. Planning and Servicing Winter Construction
2. *Winter Care and Servicing of Equipment*
3. Winter Excavation and Embankment Construction
4. Concrete Road Construction in Winter
5. Winter Heating Concrete Materials and Mix
6. Handling and Placing Concrete in Winter
7. Protecting Winter Placed Concrete
8. Winter Inclosure in Building Construction

2. Winter Care and Servicing of Equipment

EQUIPMENT which normally operates in the open requires special care and handling in winter. Equipment which is normally housed, as compressor and other power plant installations, calls for no special winter care or handling, but the servicing of these installations with power and their own transmission of power service are operations in the open and so are affected by cold and snow. Job servicing of power has been discussed in Article 1. The other practices of servicing, handling and caring for equipment in winter are outlined here.

Plant Housing—Plant housing divides into four classes: (1) Permanent housing of fixed equipment installations as power plants and central mixing plants; (2) garages and roundhouses for mobile equipment such as motor trucks, tractors and locomotives; (3) isolated shelters for scattered pumps, hoists, etc.; and (4) machinery cabs or housing on the equipment itself. All these types of housing are about as commonly required for shelter in summer as for warmth in winter, and for winter their structure needs only to be tighter and to have heating service of such nature as is practicable or necessary.

Winter Breakage—There is a conviction somewhat supported by evidence that equipment breakages are more common in cold weather. Supposition that this is due to frost making the metals of equipment much more brittle has small support in our knowledge of materials. Ice, congealed lubricants and frozen ground, however, stiffen up transmissions, weld and seal operating bearings and joints, and form a non-resilient foundation which often puts breaking stresses on equipment parts. The remedy is to warm up or to thaw out, as described later, the stiffened parts by putting the mechanism gradually into operation or by heating, and to use more consideration of the rock-like rigidity of frozen ground when moving machines over it, or when otherwise working on it. In working excavators in frozen ground there is temptation to use the bucket as a sledge to break down or as a crow-bar to pry up frozen crust too thick to be so handled. Trying to pick up or to snake without loosening, piles, timbers or other objects frozen to the ground is a common cause of breaks in derricks, piledriver catheads, etc. The examples can be multiplied. Those given, however, indicate clearly the nature of the causes of winter breakages of equipment so far as they differ from the causes which prevail at any time or temperature.

Water Supply—Only large operations of considerable duration warrant trenching and pipe-laying below the frost line. Two methods of winter operation of overground pipe lines are: (1) Boxing and insulation, and (2) intermittent use, draining or blowing out the line between periods of use. Examples serve best to explain possible applications.

For camp water supply in northern Quebec two miles of pipe on low timber bents were boxed in and the boxes filled and heated as indicated by Fig. 5 (Foundation Co. of Canada, Ltd.). On another Quebec operation farther north, extending over three years, a standard water tower gravity system, with the pipes in 6-ft. trenches, was installed (Quebec Development Co.).

On the Neebish rock channel in the St. Mary's River between Michigan and Ontario, water was supplied to steam shovels through some 12,800 ft. of overground 2-in. pipe. Water was pumped from a sump to a tank on the bank as indicated by Fig. 6. The tank held about 6,000 gal. and at it were two pumps and a 35-hp. boiler steam from which, with exhaust steam from the pumps, was used to heat the water in the tank. The delivery pipe line ran 2,500 ft. one way and 5,000 ft. the opposite way from the tank, and was laid with as few turns and valves as it could be. When the shovels wanted water it was pumped hot from the tank and kept constantly running until the shovel was supplied, when the flow was shut off and the remaining water in the pipe line was blown out with compressed air. To avoid waste of air and loss of pressure in the air lines, air was admitted to the pipe through a constricted orifice arranged as shown at Fig. 6a. This is an important practical detail. In two winters' work, seldom above freezing in January and February, the delay from frozen pipe lines was 2½ hours per winter per shovel (Grant, Smith & Locher Co.).

Winter water supply at an elevation of 7,600 ft. in

January and February, 1925, at temperatures around —40 deg., for mixing concrete for the Mystic Lake power development in Montana, was protected as follows: The source was the lake 100 ft. lower than the mixer. Here an electric triplex pump was housed in and the house heated by electric space heaters. A 1-in. delivery pipe led from the pump to the tank alongside the mixers, the tank water being heated by steam. This pipe was laid overground (actually up a cliff) inside a 2-in. pipe kept filled with enough steam to prevent freezing. This arrangement proved most satisfactory (Winston-Dear Co.).

On steam-shovel ditch excavation in western Canada water brought in tank cars was run into a track-side reservoir and pumped through a 5,000-ft. pipe line to the shovels. The pipe was laid in a 7-ft. trench and had a standpipe and check valve every 500 ft. From the standpipes water was delivered to the shovels by a 250-ft. overground pipe and a hose connection, Fig. 7. This service pipe was covered with about 6 in. of manure and each time after taking water the steam shovel blew it clear with steam. This arrangement served all winter with temperatures as low as 50 deg. below zero (Grant, Smith & Locher Co.).

Winter water supply practice developed in operating a large fleet of shovels in coal mine stripping is as follows: Delivery is overground using 1½-in. pipe coupled with unions in sections not exceeding 200 ft. and connected at the shovel so that by opening one valve and closing another steam can be turned into the line or, reversing the process, water is allowed to enter the tanks at the shovel. At the source of supply which is usually a 10,000 to 20,000-gal. tank, the connections are boxed to prevent freezing. Just outside the box is a union which is uncoupled when water is not being used. In extremely cold weather a man is stationed at this union and at intervals of approximately 30 minutes the water is shut off, the union is broken, and steam is turned into the line. At night the lines are always blown out with steam and left uncoupled, and the first thing in the morning the lines are blown out before turning on the water. It happens sometimes of course, when the source of supply is far away and the pipe lines are long, that before there is opportunity to blow back the line its entire length, freezing will begin. Then the unions in the line are loosened but not uncoupled as far back as the steam will force the water through the loosened unions. Beyond this point it is known that the pipe is frozen solid and this portion is taken apart and thawed in the usual manner (Central Pennsylvania Quarry, Stripping & Construction Co.).

Practical Lubrication—The kinds of lubricants best for cold-weather use were discussed in Article 1. At best they are compromises. Consideration under two heads is enough: (1) Cylinder lubrication and (2) transmission lubrication. About the harshest conditions of both prevail in tractor and excavator operation in the open. At best full satisfaction cannot be had. The lubricating oil used in a tractor motor, for example, must necessarily be somewhat between that which will give perfect lubrication to the cylinder while at full-load temperatures and that which will be light enough to permit turning the motor over when it is very cold. With a too-heavy oil in very cold weather when the motor is just started, the fresh oil will not be thrown onto the cylinder walls quickly enough to prevent undue wear after the oil remaining from the previous run has been used. Indeed, if a tractor or excavator engine is to be left standing in temperatures of zero or lower, only the lightest cylinder oil will meet the requirements for starting the motor cold. Yet such an oil is too light to lubricate the bearings and cylinder walls under full-load operating conditions without undue wear. Also proper lubrication of the speed change gear, bevel gear and final drive gear compartments of tractors and the transmissions of excavators requires in winter a lubricant lighter than the heavy transmission oil used in normal temperatures. Here, also the use of light oil involves the hazard of undue wear during full-load operation. A compromise is the result again, with not full satisfaction.

For the reasons indicated and because under even the best of conditions some time must be spent in starting and properly loosening up an extremely cold machine, it is real economy to provide some sort of warm storage wherever it is at all possible. Even where the contractor is shifting operations frequently he can usually and should equip himself with a portable garage in which a kerosene stove may be kept burning. Garage service

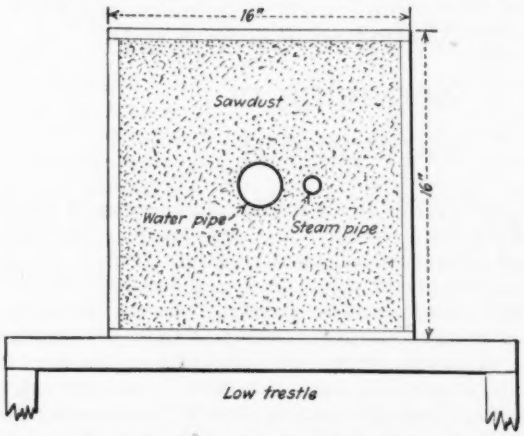


FIG. 5—INSULATION AND FROST PROTECTION FOR CAMP WATER MAIN

applies of course particularly to tractors, motor trucks, locomotives and similarly mobile equipment. It is usually impracticable for power shovels and other excavators; they have to be guarded as best can be done in other ways.

Where warm storage in garage is impracticable other resorts are: (a) Machine cabs which can be closed tight and kept heated—generally, manufacturers of excavators, cranes, etc., provide such housing as regular equipment; (b) draining radiators and refilling them when starting up again, using anti-freezing radiator solutions; draining out oiling system, keeping the oil warm and refilling the system when starting up again; keeping the oil warm by a steam pipe through the system; (c) heating and watchmen to keep fires and guard against freezing; (d) warming up and thawing out machine parts preliminary each time to starting work. Some of these practices are developed further as follows:

Radiator Protection—Frost protection of motor cooling systems may be by draining or by anti-freezing mixtures. In draining, there is danger that there may be some pockets in the cylinder jackets which do not entirely empty; a precaution, then, is to run the engine a minute or two after draining to evaporate any pocketed water. Where operators prefer draining, it should be careful and thorough. In general, the use of anti-freezing mixtures

is held preferable; a solution of alcohol or of glycerine and water, or it may be kerosene. The alcohol solution, say 40-60, or 50-50, is cheaper in first cost, but it evaporates more rapidly than glycerine. Whatever solution is used, it should be inspected at least once a day to insure that it has not changed strength and decreased its capacity to resist freezing. Kerosene cools satisfactorily and will not freeze, but carries a small element of fire hazard. When kerosene is used, the radiator cap should be removed and a standpipe the full size of the opening and 2 ft. or more high should be screwed on to prevent slopping and to carry the fumes well above the motor. Automobiles and truck and bus operation in winter have made the use of anti-freezing motor cooling compounds

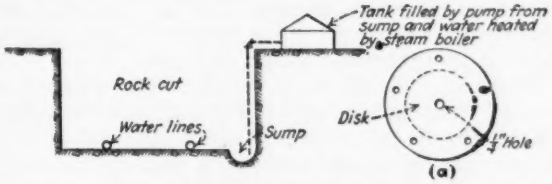


FIG. 6—STEAM SHOVEL WATER SUPPLY ON ST. MARY'S RIVER CHANNEL IMPROVEMENT

reasonably familiar and practice for construction equipment need be no different.

Warming Up Power Units—Frost has greatest effect on steam power equipment, less on gasoline units, and least on electric motors. Indeed, electric motors are more efficient electrically when cold so that the problem of winter handling involves only care in lubrication and protection from the wet. Steam and gas power units differ in their winter handling. Their handling on shovels, other excavators and cranes working in the open covers all conditions of exposed use.

With steam power, when shutting down for the night or other long period, the steam chests and all pipes where condensed steam might freeze should be drained. Then keep enough fire under the boiler to prevent the water tanks from freezing. This calls for a night watchman. In the morning he should get up steam and have the machinery warmed up before the operating crew comes on duty. In starting up a steam unit it is a help to have a steam pipe connected through the mechanical lubricator to keep the oil warm and free-flowing. In greasing up, use hot grease.

With gasoline or Diesel engines, radiator protection by draining or by using non-freezing compounds comes first and has been described. Next is the selection of lubricants as previously outlined. Warming up the engine is, then, the main remaining winter requirement, and this varies in practice both in manner and in duration. In general, the warming up period must be long enough to bring the engine to a temperature where it will deliver the rated power. This period is reduced if the cab or house is kept heated over night and many operators provide cab heaters in winter. Some find it an advantage with Diesel engines to use a lighter fuel oil in winter. One operator outlines his practice with gas engine excavator units as follows:

In winter a medium, or, in the cold northern states, a light oil should be used. The oil should be drained off at night and kept in camp where it will be warm in the morning to put back into the engine. This will avoid trouble from possible freezing up of the oil pump and will insure proper lubrication when the engine first starts to turn over. If it is not done, it is possible that some seizure in the bearings or some cutting may develop before the oil is thoroughly warm. In cold weather the oil should not be used at a maximum of more than two-thirds as long as it is in the summer. Not more than half as long would be still better, as the light oils will not stand up like the heavy oils suitable for warm weather. When the operator arrives at the machine in the morning, he should immediately put in the warm oil and start the engine, letting it idle while he greases up the rest of the machine. By this procedure, the engine will be ready to carry the load when the rest of the machinery has been greased.

Warming Up Tractors—One of the most exacting tasks is warming up tractors of the gas-engine, crawler-tread type. The following directions contain many practices which can be applied to other gas engine power units.

All tractors when shipped from the factory are lubricated for normal operating conditions. If a tractor is to be used in low temperatures, it will be necessary to change the oil as soon as it has been unloaded and operated long enough thoroughly to warm the oil in the motor and the various transmission compartments, so that it may be drained off. If the tractor is in a car, the interior of which is very cold, it may be necessary to warm the oil somewhat before the tractor can be unloaded with safety. The same condition may be encountered occasionally when it becomes necessary to warm up a tractor which is normally warm stored, and is lubricated accordingly, but which has been left out where it could get very cold.

If a steam jet is available, it furnishes the quickest and easiest method of applying heat. Otherwise, a gasoline blow torch, or a torch made of rags wrapped around a stick and soaked with kerosene, may be used. Care should be taken to apply the heat gradually to the various parts of any casting, that it may have time to expand equally throughout. The parts to which heat should be applied are, in order, the bottom of the speed change compartment (this first, because it contains the largest quantity of lubricant, will take longest to warm up, and

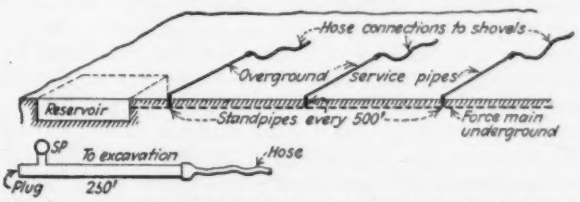


FIG. 7—STEAM SHOVEL WATER SUPPLY ON DITCH WORK IN WESTERN CANADA

will hold the heat longest), the bevel gear compartment, the final drive gear compartments, the cylinder walls and the intake manifold. The carburetor bowl may be warmed just before the motor is to be started, by wrapping it in cloth and applying boiling water. Fire should not be used on the carburetor, due to the possibility of an explosion. Heat will reach the interior of the cylinder walls and the pistons much more readily if the cooling system is empty.

Particular care should be taken to apply heat to those parts where brass or bronze bushings are used. Brass contracts with cold more rapidly than does iron; therefore, at low temperatures such a bushing is likely to have a very close fit which will prevent lubricant reaching the bearing, when the tractor is started, in time to prevent damage.

If the motor crankcase contains very light oil, and has been standing longer than over night, there will be a

possibility that the oil may have drained away from the cylinder walls to such an extent that damage may result when the motor is started, before fresh oil will reach these surfaces. In such cases, it will be well to remove the spark plugs and squirt a few tablespoonfuls of oil on the top of each cylinder. The motor should then be turned over several times to allow this oil to work down to the rings and piston walls. This procedure will also improve the motor compression and thus facilitate starting.

Another method of warming the interior of the cylinders is as follows: Turn the motor over until the pistons are all equidistant from the tops of the cylinders. Remove the spark plugs and squirt a spoonful of gasoline on top of each piston. Then apply a lighted match to the spark plug hole, keeping the hand and face out of the way of the resulting spurt of flame. This operation should be repeated half a dozen times for each cylinder. Sometimes the cylinder in which the exhaust valve is open will not ignite easily, in which case it may be necessary to burn out the other cylinders and then turn the motor over once to close that valve. This heating action, also, will of course be more effective if the cooling system is empty.

If the gasoline available for priming the motor is lacking in volatile units, and so does not vaporize readily, it may be necessary in extremely cold weather to use ether for priming the motor. However, this will rarely be necessary if the cylinder walls and intake manifold are warmed as above outlined.

Freezing of Caterpillars—Crawler treads will freeze if left standing in mud or water. Tearing them loose by throwing on the power invites tread breakage. At night the machine should be run up onto ties, timbers, poles, large stones, or anything which will lift the tractors off the ground. In case of freezing, any of the heating or thawing methods previously described can be employed to thaw the ice away. One operator who uses many steam shovels reports: "Conditions govern our practice; if in clay or wet material, the caterpillar shovels are run up onto ties for the night, and if on rock bottom, a few rocks are thrown under the treads to elevate them. In the morning a steam hose is connected to the shovel and by playing steam a short time on the treads the caterpillars are free." A gasoline shovel operator states: "When work is finished for the day the machine should, during the winter months, be traveled up on planks or poles laid on the ground. Where slippery ground has to be moved over due to sleet or ice or mud with frost underneath, it is well to put grousers on the shoes to prevent the machine from receiving or inflicting damage by skidding."

New Maps of Texas and Oklahoma

New maps of the oil fields of Oklahoma and Texas, showing the locations of pools from which increased yield is being obtained, also of many new wildcat wells, are being published by the U. S. Geological Survey. The maps are printed in colors. Oil fields are shown in green, gas fields in red, and refineries, oil pipe lines and salt domes in purple. The base, showing county and land lines, streams, towns and railroads, is printed in a subdued tint to emphasize the oil and gas features. The scale is sufficiently large so that those interested can record further developments. The Oklahoma map is 64x34 in. and of Texas 74x57 in. They may be obtained for 50c. from the U. S. Geological Survey, Washington, D. C.

A Problem of Municipal Water Supply in the Oil Fields

With Former Sources Polluted by Oil and Salt Water New Impounding Reservoir Is Located on Non-Oil-Producing Syncline

By F. M. Veatch
With Black & Veatch, Consulting Engineers, Kansas City, Mo.

EL DORADO, Kansas, is a well-known town in the mid-continent oil fields which changed from a rural county seat of three thousand inhabitants in 1914 to an oil town of twenty-thousand in 1917. Since 1917 the population has decreased and at the present time is fairly stable at approximately fifteen thousand.

Previous to the oil boom, the city water supply was obtained from shallow wells in the Walnut River valley, but this supply quickly proved inadequate, and in 1916 the city installed a water purification plant to take water from the Walnut River direct. This supply proved adequate in quantity and was of satisfactory quality until the oil development extended above El Dorado on the Walnut River watershed. Then the wastes from the oil wells, in the form of salt water and crude oil, began to pollute the river which, however, up to 1920, was usable for parts of the year. Soon thereafter the condition became intolerable, and the use of the city water for domestic purposes was practically discontinued, and early in 1925 the city had a careful survey of the water resources made.

The survey included both surface and ground water supplies, for the purpose of determining the best method of obtaining an adequate supply of good water. As shown on the accompanying map, the oil development has been very general around El Dorado and it was found that extensive drilling had affected the ground water in the vicinity, presumably through migration of salt water from the lower to higher levels or through improperly plugged or improperly cased wells.

Practically all of the subsurface flow was found to be too saline for municipal use. The surface runoff on the majority of the larger catchment areas in this district was also affected to such an extent that impounded supplies would be unsatisfactory.

From the results of the survey it was shown that the choice of a water supply lay between a ground water supply to be developed in the Arkansas River valley some thirty miles west of El Dorado at a cost of approximately $850,000, and an impounded surface supply from one of the drainage areas lying east of the city which could be developed for approximately $400,000.

The Satchel Creek area (the northerly one of the three areas shown on the map) was chosen for development since it is situated on a syncline where numerous tests for oil indicate no possibility of future development. Satchel Creek also affords an impounding reservoir site on which the required amount of water may be stored more economically and at a greater average depth than is possible on the other streams. A careful study of the railfall records of this section indicated that a storage capacity of 785 m.g. (330-acre reserovir approximately 8 ft. deep) at this site will permit a continuous draft of 3.5 m.g.d. or enough to supply the city of El Dorado for at least twenty years in the future.

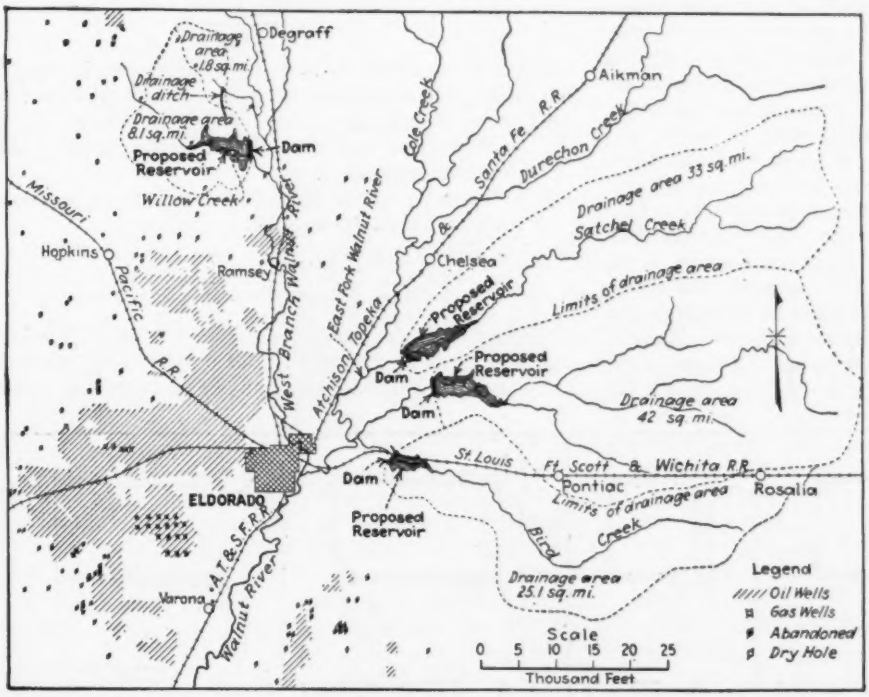
Contracts let in January, 1927, to carry out these water supply plans include an earth fill dam, spillway, 24-in. cast-iron flow line, and a 1½-m.g. clear water reservoir, and represent a total cost of $288,000. The necessary land and right-of-way was acquired for approximately $100,000, which brings the total cost of the project to approximately $390,000. Unit prices for the work were:

Earth excavation	$0.35 per cu.yd.
Loose rock	1.00 per cu.yd.
Solid rock	1.50 per cu.yd.
Borrow, earth	0.30 per cu.y.d
Clay corewall	0.40 per cu.yd.
Sheetpiling in place	80.00 per M.B.M.
4-in. reinforced-concrete slope paving	1.75 per sq.yd.
Plain concrete	15.00 per cu.yd.
Reinforced concrete	25.00 per cu.yd.
Fencing	3.30 per rod
24-in. cast iron pipe installed	6.00 per lin.ft.

The dam is approximately 1,900 ft. long with a maximum height of 37 ft. and a crest width of 12 ft. The soil at the dam site is clay which lies to an average depth of 14 ft. on a gravel bed which is from 1 to 6 ft. in thickness. It is proposed to construct a concrete core wall to rock across the old stream bed and to use a cutoff wall of Wakefield piling throughout the rest of the dam, wherever the gravel stratum is encountered. A curved concrete spillway wier, 400 ft. long, with a gravity cross-section, will be constructed on solid rock at one end of the dam, where an outcrop of limestone is so located as to form an excellent foundation as well as a naturally paved wasteway.

The 24-in. flow line, 2,240 ft. long will deliver water to the city filters. The existing filter plant, which has a nominal capacity of 2 m.g.d., will be used until it becomes overloaded when the demand upon it will be reduced by furnishing raw water direct from the flow line to the railroads and refineries which are the largest individual consumers.

The project has been designed and the construction work is being supervised by Black & Veatch, of Kansas City, Mo. The Stimson Construction Co., Topeka, Kan., is the contractor.



DRAINAGE AREAS CONSIDERED IN LOCATING NEW WATER SUPPLY FOR OIL TOWN OF EL DORADO

Satchel Creek area was chosen and is now being developed.

Ground Water in New Mexico Now Subject to Appropriation

ADMINISTRATIVE control of the waters of the Roswell artesian basin in New Mexico was assumed by Herbert W. Yeo, state engineer, on July 1, 1927, in accordance with the recent law. The act applies to all the ground waters of the state, which will hereafter be considered as "public waters." The act is an outcome of a study of the Roswell artesian basin located in Chaves and Eddy Counties, made by A. G. Fiedler, associate engineer, U. S. Geological Survey, Roswell, N. M. A preliminary report was published in the seventh biennial report of the state engineer of New Mexico. The investigation of this artesian area is being continued by the Geological Survey to obtain data to facilitate the proper administration of the law. The act reads:

Sec. 1. All waters in this state found in underground streams, channels, artesian basins, reservoirs, or lakes, the boundary of which may be reasonably ascertained by scientific investigations or surface indications, are hereby declared to be public waters and to belong to the public, and subject to appropriation for beneficial uses under the existing laws of this state relating to appropriation and beneficial use of waters from surface streams.

Sec. 2. The state engineer shall have the supervision and control of all such underground waters and of the method and manner of appropriation and use thereof, under the laws of this state.

Sec. 3. All waters of such underground streams, channels, artesian basins, reservoirs or lakes, now being used for beneficial purposes are hereby recognized as valid appropriations of such waters and hereby confirmed and such use shall be subject to the rules and regulations of the state engineer under the laws of this state.

Sec. 4. This act is not intended to apply to the construction of wells by persons, corporations or municipalities to obtain water for domestic or stock watering purposes.

Sec. 5. Upon the passage and approval of this Act the State Engineer of the State of New Mexico shall proceed to the administration of the same as to any particular underground stream, channel, artesian basin, reservoir, or lake as defined in Sec. 1 hereof, upon a petition being presented to him requesting him so to do, signed by not less than 10 per cent of all the users of waters of such defined underground streams, channels, artesian basins, reservoirs, or lakes.

Sec. 6. That it is necessary for the preservation of the public peace, health and safety of the inhabitants of the State of New Mexico, that the provisions of this Act shall become effective at the earliest possible time, and therefore an emergency is hereby declared to exist, and this Act shall take effect and be in full force and effect from and after its passage and approval.

Details for Wind Connections in Tier Buildings

Connections Using Angles and I-Beams—Several Types of Bracket—Connections for Double Girders

By Walter H. Weiskopf
Weiskopf and Pickworth, Consulting Engineers,
New York City

IN PULLING a bucket of water up from a well it is as important to have one end of the rope securely tied to the bucket as it is to have a good rope. Similarly, in a wind-braced building it is as important to have columns and girders well connected, as it is to have them properly designed. Yet almost nothing has been written on wind-bracing details. The detail is often a crucial point and governs many design features. In this article some of the best details in common use will be discussed.

The theoretically perfect detail, then, is strong and cheap, and encroaches as little as possible on the architectural clearances. The value of a practical detail depends on how nearly it approaches these requirements.

Simple Beam Connections—The simplest connection is of course the common framing angle (type *A* in Fig. 1). This is inexpensive and occupies little room, but it has little rigidity. Next in order of strength is the top-and-seat-angle connection (types *B, C,* and *D*), and the combination of framing angles with top and seat-angles (types *E* and *G*). These details encroach but little on the architectural clearances of a building, and are satisfactory where wind moments are small enough.

Each of them depends on the strength of rivets to resist tension; a pull on the rivet head. The critical feature is the riveting between the column and the outstanding legs of the angles. Sufficient rivets can always be placed in the beam flanges by extending the connection horizontally (if necessary, cut channels instead of angles can be used for seat and top connections).

The thickness of the angles in relation to the gage and size of rivets should be studied. It can be approximately analyzed as follows. Referring to Fig. 2, the bending moment per inch of angle is

$$m = \frac{r(g-t)}{2f}$$

and the required thickness is

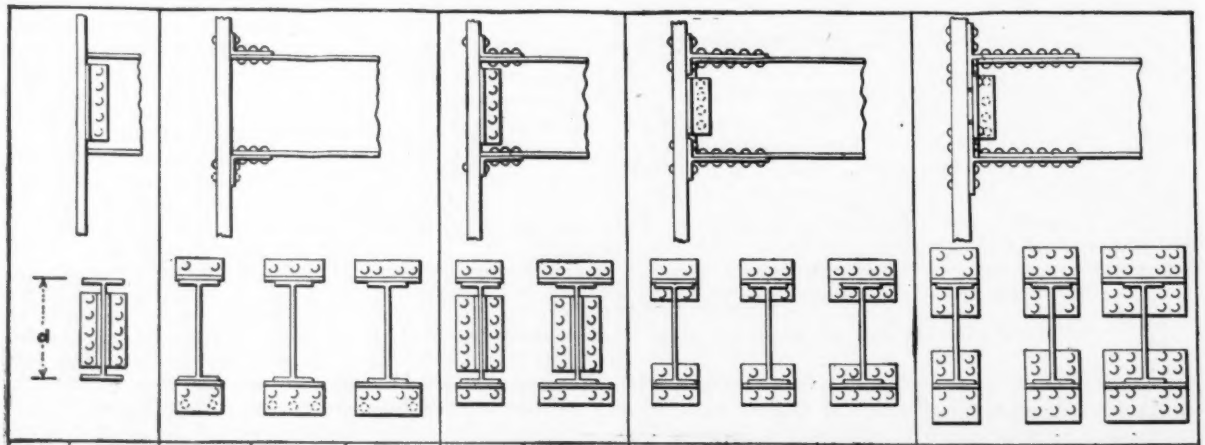
$$t = \sqrt{\frac{3r(g-t)}{kf}}$$

where k is the allowable extreme fiber stress. It should be noticed that increasing the allowable unit stresses for wind, as is usually done, does not affect this equation, since both the rivet value r and the bending stress k are increased proportionately.

The following gages and thicknesses of angles have been found to be satisfactory for usual cases:

Rivet size, in.	¾	⅞	1
Gage	1¾	2	2
Thickness of angle	½	⅝	¾

Similar analysis should be applied to the framing angles in types *A, E* and *G*. But it frequentiy happens that the gages in the column must be so large that small



d	A	B	C	D	E	G	H	K	L	M	N	P
10	0.50	2.33	3.50	4.67	2.44	4.77						
12	1.00	2.67	4.00	5.33	3.04	5.71						
14	1.00	3.00	4.50	6.00	3.33	6.34	4.84	6.05	9.68			
15	1.67	3.17	4.75	6.33	3.96	7.12	5.16	6.45	10.30			
16	1.67	3.33	5.00	6.67	4.09	7.42	5.52	6.90	11.00	11.0	13.8	22.0
18	2.50	3.67	5.50	7.33	5.03	8.70	6.16	7.70	12.30	12.3	15.4	24.6
20	2.50	4.00	6.00	8.00	5.25	9.25	6.84	8.55	13.70	13.7	17.1	27.4
21	3.50	4.17	6.25	8.33	6.26	10.40	7.16	8.95	14.30	14.3	17.9	28.6
22	3.50	4.33	6.50	8.67	6.36	10.70	7.48	9.35	15.00	15.0	18.7	30.0
24	4.67	4.67	7.00	9.33	7.66	12.30	8.16	10.20	16.30	16.3	20.4	32.6
26	4.67	5.00	7.50	10.00	7.80	12.80	8.84	11.00	17.70	17.7	22.0	35.4
27	6.00	5.17	7.75	10.30	9.24	14.40	9.16	11.40	18.30	18.3	22.8	36.6
28	6.00	5.33	8.00	10.70	9.27	14.60	9.48	11.80	19.00	19.0	23.6	38.0
30	7.50	5.67	8.50	11.30	11.50	16.60	10.20	12.70	20.20	20.2	25.4	40.4

Section Moduli in Feet

Section Modulus Times Value of One Rivet in {Thousands of Pounds / Tons} Equals Resisting Moment in {Thousands of Foot Pounds / Foot Tons}

FIG. 1—TOP-AND-SEAT-ANGLE CONNECTIONS, AND THEIR SECTION MODULI

gages in the framing angles cannot be maintained. For this case the section moduli for type *A* should be reduced, and those for types *E* and *G* reduced, or replaced by the section moduli of types *B* and *D*. It is common practice to provide framing angles for the vertical load and not count them as part of the wind bracing.

Heavy Beam Connections—Types *H* to *P* (Fig. 1) are modifications of the top-and-seat-angle detail in which greater strength is obtained by using an I-beam from which one flange has been cut. The encroachment on the

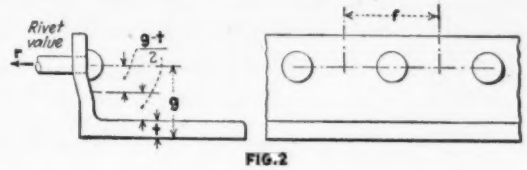


FIG. 2

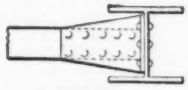


FIG. 3

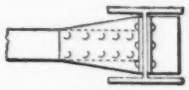


FIG. 4

FIGS. 2 to 4—STIFFNESS OF ANGLES AND OF COLUMN WEBS

architecture is slight. The required flange thickness can be determined as in the previous cases. It has been found that for 1-in. rivets the flanges in types *M*, *N* and *P* must be $1\frac{9}{16}$ in. thick. The only rolled sections suitable are consequently the Carnegie 30-in. *CB* at 240 lb., or the Bethlehem 30-in. *BG* at 200 lb. A 14-in. Bethlehem column with plates added to fasten its web to the beam flange could also be used.

In Fig. 1 section moduli for types *A* to *P* are given. In general these details are not equal in strength to the beams which they connect. With usual unit stresses and 1-in. rivets, except for shallow beams, type *P* is the only detail that develops a moment equal to that of the lightest-weight I-beams; for the 30-in. beam even type *P* is shy.

Frequently, because of architectural conditions, a beam must frame eccentrically into a column instead of on the center line as shown in the figures. This obviously weakens the rivet group. In types *H* to *P*, moreover, the web of the I-beam is likely to block the driving of two or more rivets. Such cases need special study.

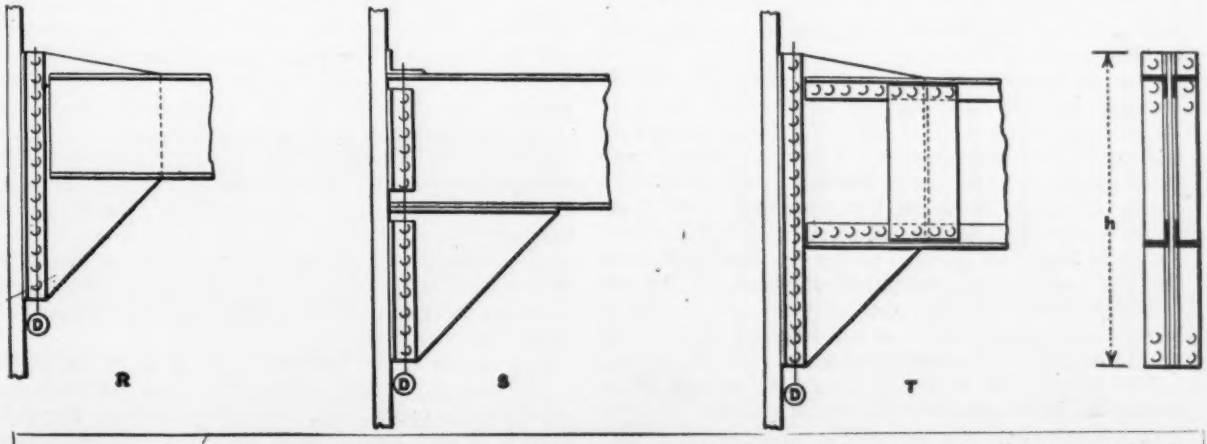
Engineers and architects too commonly believe that so long as the members are properly designed their exact position is immaterial, since some sort of a satisfactory detail can always be patched together. Actually, however, a slight change in a beam location, which does not appreciably affect the architecture, often greatly improves the detail. Among the factors entering into the location of beams, the effect on the detail should be considered.

Stiffening the Column Web—It is not the purpose of this article to discuss column design except in its relation to the wind connection. Provision should always be made to resist the pull from the wind detail. In Fig. 3 a thin column web is obviously incapable of resisting the pull from the center rivet. This can be rectified by adding a stiffener opposite the wind connection, Fig. 4.

Occasionally the peculiar case of a heavy wind connection on a comparatively light column arises. The designer should satisfy himself that the column flange is thick enough to withstand the pull from the outside rivets. In plate-and-angle columns the web riveting should be investigated by considering the column as a plate girder, with the forces from the wind connections as loads. Note that the connections on opposite faces of the column must be added, and do not counterbalance each other. It is sometimes necessary to add reinforcing web plates at the wind connection to get additional value from the web rivets. These plates usually must be so long that it is economical to run them full length of the column and figure them as part of the column section.

Bracket Connections—With type *P* the limit is reached in connecting an I-beam to a column without the use of brackets. Brackets as shown in types *R*, *S*, and *T*, (Fig. 5) are usually objectionable architecturally, but there are some places where they can be used to advantage; for instance, where hidden in a partition, or between elevator shafts, or in the outside walls. Sometimes they must be used even at sacrifice of architectural features.

Fig. 5 gives section moduli for brackets. The thick-



A	1′ 3″	1′ 6″	1′ 9″	2′ 0″	2′ 3″	2′ 6″	2′ 9″	3′ 0″	3′ 3″	3′ 6″	3′ 9″	4′ 0″	4′ 3″	4′ 6″	4′ 9″	5′ 0″	5′ 3″	5′ 6″	5′ 9″	6′ 0″	6′ 3″	6′ 6″	6′ 9″	7′ 0″	7′ 3″	7′ 6″
Rivets in vert. line, approx..	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Section modulus	2.50	3.50	4.67	6.00	7.50	9.17	11.0	13.0	15.2	17.5	20.0	22.7	25.5	29.5	31.7	35.0	38.5	42.1	46.0	50.0	54.1	58.5	63.0	67.6	72.5	77.5

Section Moduli in Feet

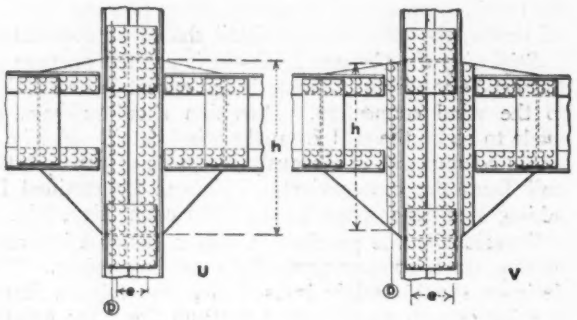
Section modulus times value of one rivet in { Thousands of pounds / Tons } Equals resisting moment in { Thousands of foot-pounds / Foot-tons }

Rivet spacing 3 in., approximate.

FIG. 5—BRACKETS TO FACE OF COLUMN

ness of connection angles and gusset plate should of course be considered. For economy the gusset plate should be thick enough to put the rivets in double shear. For these details this thickness of plate will also be sufficient for bending at the net section, along line *D*.

For these brackets, from a theoretical standpoint, the stress on the extreme rivet of a group from the wind moment should be combined with that from the vertical load. This procedure should be followed if the vertical



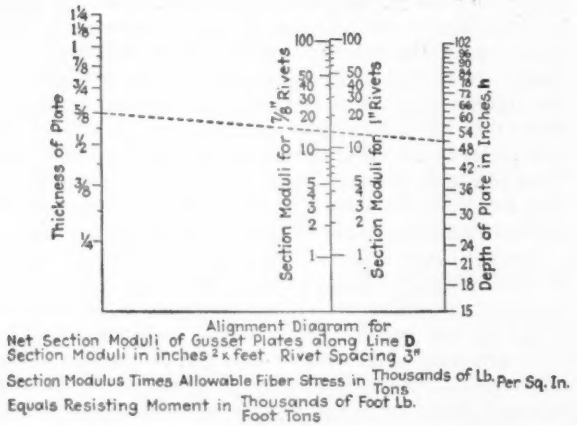

Thickness of Plate
Section Moduli for 7/8" Rivets
Section Moduli for 1" Rivets
Depth of Plate in Inches, h
Alignment Diagram for
Net Section Moduli of Gusset Plates along Line D
Section Moduli in inches² x feet. Rivet Spacing 3"
Section Modulus Times Allowable Fiber Stress in Thousands of Lb. Per Sq. In.
Equals Resisting Moment in Thousands of Foot Lb.
Foot Tons

FIG. 6—INSERTED BRACKET CONNECTIONS

load is large. It is usually so small, however, that it does not affect the size of the group, and consequently can be neglected.

Another type of bracket is type *U* (Fig. 6). This is stronger for the same size (or smaller for the same strength) than types *R*, *S*, and *T*. Since it requires slotting of the cover plates and splicing of the web, and is more difficult to ship, it is also more expensive. The critical feature is the strength of the gusset plate along its net section, through the line of rivets, *D*. Fig. 6 also shows an alignment diagram giving the relation between the thickness of plate, the depth of plate, and the net section modulus. If any two of these are known, a straight line connecting them will intersect the axis of the third at its corresponding value.

The gusset plate of course must have enough rivets to transfer its moment into the column angles. For type *U*, the number of rivets between the gusset and each pair of flange angles is given by the expression M/er, where M is the sum of the wind moments on the two sides of the column, r is the value of one rivet, and e is the effective depth of the rivet lines. To satisfy this requirement it is occasionally necessary to add clip angles as shown in type *V* (Fig. 6), thus securing additional rivet lines. It is sometimes wise to add reinforcing web plates the full depth of the connection instead of using small splice plates as shown, since then the group of rivets in the gusset plate can be figured according to its polar section modulus.

The architecture of a building occasionally permits the use of either diagonal members or angle kneebraces to withstand wind forces. The connections of diagonals to columns or girders are too special, and too infrequently used to be discussed here, while kneebrace connections are so common as not to require mention.

Double Girder Connection—An excellent detail, first used to the writer's knowledge by S. C. Weiskopf on

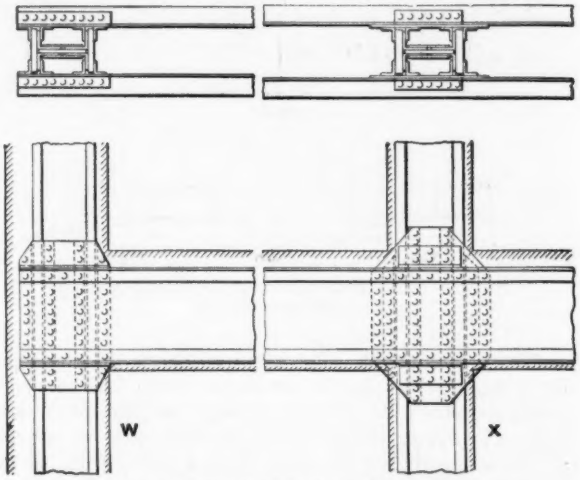


FIG. 7—DOUBLE-GIRDER CONNECTIONS

the Trinity Building, New York, in 1903, capable of carrying large moments without the objectionable brackets, makes use of double channel-shaped plate girders. Two examples of this are types *W* and *X*, Fig. 7. Some of the variations of this scheme are the use of 15-in. structural or 18-in. shipbuilding channels, with or without flange plates; or, for larger moments, I-beams with the flanges blocked on one side (and if necessary compensated for by flange plates on the other side).

The strength of the connection can be determined by the polar section modulus of the rivet group, which is seen to be large. The gages, thicknesses of connection angles, and column web riveting when plate and angle columns are used, should be investigated. Since the maximum moment from wind is at the column, the flange angles of the girders must be completely developed in the connection itself. This makes clip angles necessary even in type *X*, though not needed to connect to the column.

If the wind bent consists of only three columns, the girders need not be spliced, but can run past the center column. Where a splice is necessary, it can best be placed between columns.

One objectionable feature of this detail is the width of the haunch. Where suspended ceilings are used, this objection disappears, and where they are not, the wide haunch is less objectionable than the brackets which would have to be used under single beams carrying the same moment.

The variations of wind connections to suit the preference of the individual designer and the peculiar conditions of any building are almost endless. The details described in this article, however, are typical of the best present practice. The field of riveted connections of

beams to columns has been so thoroughly worked over in the last few decades that small opportunity is left for further development. With the recent introduction of welding into structural work, this subject can be approached from a new angle. Although a welded wind connection superior to any riveted detail may be developed in the future, for some time to come the old-fashioned riveted connection will hold sway.

The writer is indebted to the American Bridge Co. for permission to adapt portions of the tables of its publication "American Bridge Company Engineering Standards, 1926" for use in this article.

Larger Water Supply for Church Community Near Kansas City

Concrete Slab Dam Built at Cost of $100,000—Mechanical Filters, Chlorination Plant Pumps and Elevated Tank

By C. F. Lambert
Burns & McDonnell Engineering Co.,
Kansas City, Mo.

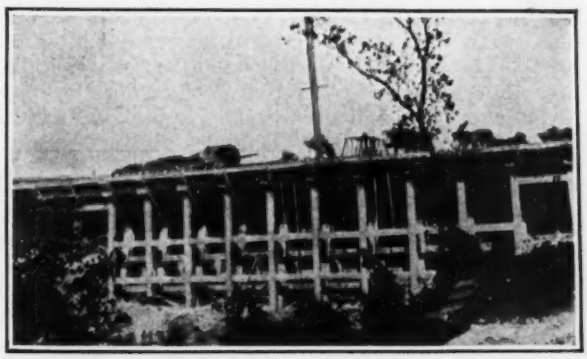
THE Unity School of Christianity, in connection with its activities in Kansas City, Mo., operates a large publishing establishment and a restaurant. The school has for some years owned a large farm about twenty miles east of Kansas City, where all fruit and vegetables served in its restaurant are grown. Additional land has been acquired from time to time until now the farm includes more than 1,000 acres, and it has been decided to move the entire establishment to the farm. Ground has already been broken for a group of buildings which will cost about $2,000,000. In a few years it is expected to have a city of about 4,000 people surrounding these buildings, and eventually 10,000 or more.

There have been located on the farm for some time, in addition to the regular farm buildings, several residences and a club house. There is, also, a nine-hole golf course. To furnish a water supply to these buildings, a small stream flowing through the farm was utilized, the water being filtered through a small mechanical filter, chlorinated, and stored in a 50,000-gal. elevated tank. For the larger development this was inadequate and an investigation was made for a larger water supply. A location was found on the farm suitable for the construction of a dam. It was at first thought that an earth dam could be built. Investigation showed, however, that the soil, containing a large percentage of clay, contained too little sand to be adaptable for this purpose. Also, to obtain enough earth would have meant clearing to the rock over a large expanse of territory. This would have detracted from the natural beauty of the lake, which was also a factor to be considered.

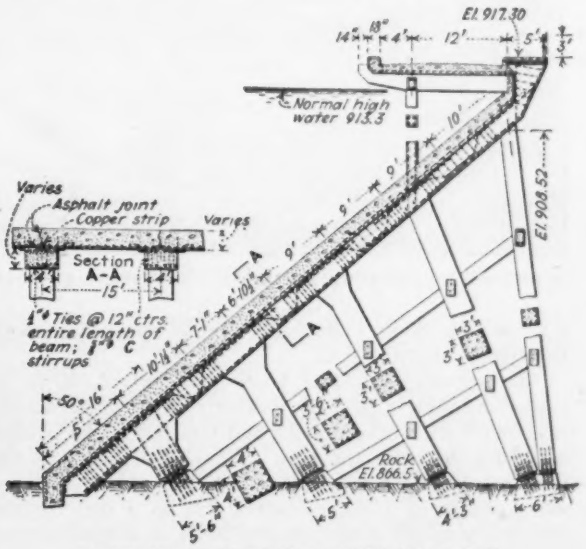
A concrete dam was decided on. The dam is about 500 ft. long and 45 ft. high at the highest point, although the height from base of foundations to top is about 60 ft. It is of the flat slab type. A concrete roadway 18 ft. wide extends the full length of the dam. The dam cost about $100,000. The lake, when full, will cover about 20 acres and have a capacity of about 70 m.g.

DAM UNDER CONSTRUCTION FROM ABOVE
A roadway is carried across the dam.

Water will be discharged through a gate tower to a mechanical filter located just below the dam. Only in case of extreme low water will it be necessary to pump from the lake to the filter.



VIEW OF DAM FROM BELOW



CROSS-SECTION OF DAM WITH ROADWAY

From the filter plant the water will be pumped through a 16-in. pipe line to the elevated tank. A new tank will be built with a capacity of 0.1 m.g., at an elevation of 100 ft. to the base. This tank and tower will be ornamental, and designed to harmonize with the group of buildings near which it will be located.

The Burns & McDonnell Engineering Co., Kansas City and Los Angeles, are engineers for the work.

From Job and Office

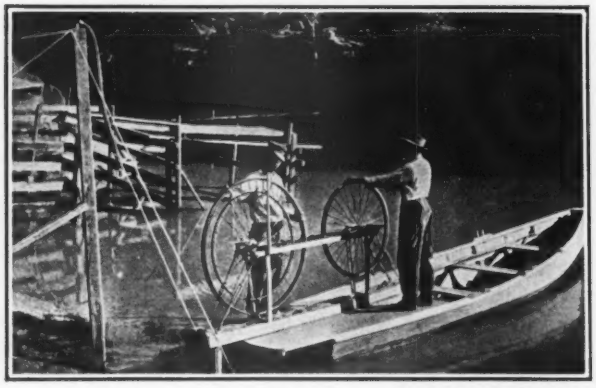
Hints That Cut Cost and Time for the Contractor and Engineer

Sounding Machine Successfully Used on Hydrographic Surveys

By E. W. Lane
Hydraulic Engineer, Mississippi River Spillway Board, New Orleans, La.

ENGINEERS of the Fourth District of the Mississippi River Commission have developed a type of sounding machine which has been successfully used by them on hydrographic surveys requiring a high degree of accuracy.

The equipment used consists essentially of two metal reels mounted on a frame on the rear of a skiff as shown in the accompanying photograph. The rear reel carries the sounding wire and the other reel carries a wire which measures the distance from a known point on the shore to the machine. The distance wire passes from the forward reel over an idler in the bottom of the frame through a trumpet-shaped metal piece at the rear end and then to the fixed point on the shore. The sounding line with the lead attached to it falls vertically through the frame from the reel.



SOUNDING APPARATUS ARRANGED FOR RADIAL WORK

The sounding reel is a wire-spoked wheel, 50 in. in diameter having a steel hoop exactly 10 ft. in circumference made of 1-in. channels, and attached to the spokes concentrically with the rim. This hoop serves as the reel for the sounding wire. The rim of the distance wheel, made of 1½-in. channels, acts as a reel for the distance wire and is also exactly 10 ft. in circumference. The distance wheel is fitted with a dog, whereby the wheel may be locked in any desired position. Each wheel is fitted with a dial and an adjustable index geared to the axle to indicate the number of revolutions. These dials are calibrated to indicate distance or depth in feet.

The distance wire consists of 750 ft. of No. 17 steel wire and the sounding wire consists of 250 ft. of No. 12 steel wire. The lead weights used vary in weight from 18 to 25 lb., depending upon the depths and velocities in which the soundings are made.

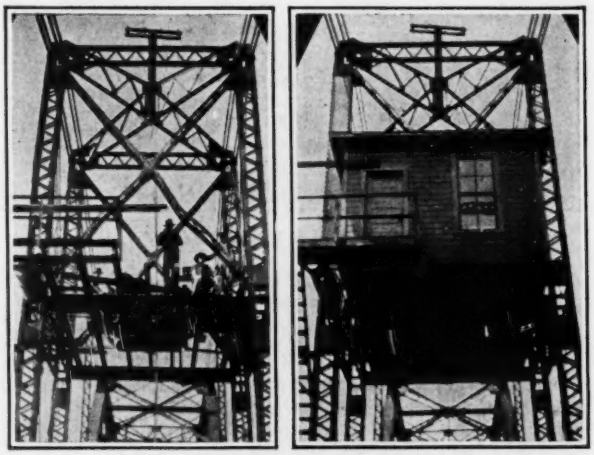
When soundings are taken over an area, the distance wire is fastened to a pivot on the shore, which may consist of a vertical pole, if trees or piles are not available. To take up sudden strains in the distance wire a 2-in. coil spring, 2 ft. long is used near the pivot. Soundings are then taken, usually at multiples of 10 ft., along arcs of circles of which the pivot is the center, always keeping the distance wire tight. Their positions are located by means of a plane table.

Soundings may be taken with this machine at 1,300 points in a day, with points 20 ft. apart, by a hydrographic party consisting of a chief, instrument man, leadsman, recorder, engineman and helper.

Repair Buckled Posts in Swing Span

A SUCCESSFUL job of bridge repair involving buckled truss posts was carried out recently in the through-truss 317-ft. swing span over the Ouachita River, Arkansas, on the Chicago, Rock Island & Pacific Ry. In a fire which destroyed the engine and operating house, mounted between the trusses, the middle posts of the trusses warped so as to buckle outward above the machinery deck. In one truss the bulge of the two middle posts was about 2 in., but in the other truss it was only ⅜ in. Each post was composed of built-up channels, laced in planes at right angles to the track. It was decided that the smaller buckling could be left, but that the two other posts must be straightened. The general scheme was to replace the lacing by a plate on each side, shouldered between the batten plates on the post. The views show the conditions before and after the repair work. The buckled diagonal bracing was replaced with new material.

For the repair of the two posts, four ⅜-in. plates, 20 in. wide and 16 ft. 11 in. long, were punched to conform to half the rivet spacing of the lacing bars in the posts. That is, the plate had holes at the rivets and midway between them. With rivets cut out of the inner member or channel of the post for removal of sufficient



TRUSSES OF SWING SPAN

Left view shows buckling of two posts and diagonal bracing between them. Right view shows one post straightened and fitted with cover plates. New diagonal bracing was placed.

lacing to permit this part of the post to be pulled inward, each plate was set in place and secured at the top by bolts through the empty rivet holes in that channel. Pulling jacks were then attached to chains wrapped around this side of the post and around a convenient member in the opposite truss. In this way the inner part of the post was gradually drawn in, drift pins being used to match the holes in the plate and post until bolts could be put through.

When this process had continued to the bottom of the plate, it was repeated with the outer channel of the post, the straightened post being thus bolted to the two cover plates. The next step was to drill through the intermediate or open holes in the plate into the legs of the angles forming the channel sections of the post. Bolts were put through these holes as they were finished. Then alternate bolts were replaced with rivets, and finally the other bolts were similarly replaced and the plate thus permanently riveted in place. This method of repair was devised by Bert Matheis, chief bridge inspector, and was carried out by a bridge gang under his direction. It was approved by I. L. Simmons, bridge engineer, and C. A. Morse, chief engineer of the Chicago, Rock Island & Pacific Ry.

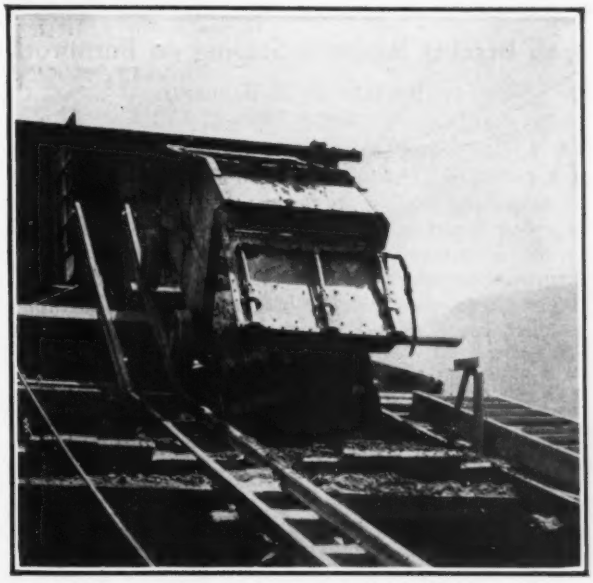
Device for Dumping Aggregate Cars at Top of Incline

IN DELIVERING concrete aggregate to bunkers at the top of an incline on the Pacoima dam construction job in California, a device is used for automatically dis-

CAR READY TO DUMP INTO A ROCK COMPARTMENT
Buffer at left, set in tripping position, can be swung into the clear when destination is farther along.

charging materials from the cars that operate on the incline. Sand and three sizes of rock are handled in separate loads, by two cars each operating on a separate track. Accordingly, at the four dumping points on each track a buffer was mounted on a hinge so placed that the buffers could be kept back in the clear or swung out by an attendant to trip a lever that would release the tailgate on the passing car.

Although the incline is as steep as 45 deg. in some places, over the bunkers the slope is only 26 deg. This is sufficient to insure the complete emptying of the cars of rock when the tailgate is opened. The sand, however, would not discharge on this grade and in order to insure complete and automatic dumping of the sand the rails over the fourth dumping point on each track, that is, over the bunker farthest up the incline, were tilted up



CAR DUMPING SAND INTO FOURTH COMPARTMENT
Note steeply inclined rails that tilt car to assure complete discharge.

at a steeper angle, as the accompanying illustration shows.

With this arrangement the buffer for tripping cars over the sand bunker could be left permanently in place so that the attendant is required to set only the buffers which dump the three grades of rock.

The device was developed by Bent Bros., contractors on Pacoima dam, to whom *Engineering News-Record* is indebted for the foregoing.

Filling Small Sewer with Cement Gun Found Cheaper Than Removing It

DURING the widening of a road in Ealing, London, it became necessary to scrap an old 9-in. vitrified clay sewer to prevent it from being used again. Filling the sewer with concrete by means of a cement gun was found to be cheaper than removing it. The sewer was 1,530 ft. long and varied in depth from 2½ ft. to 6 ft. There were six manholes located on the line, the maximum distance between manholes being 420 ft.

The method used was to push the nozzle half way from one manhole to the next and then start shooting concrete. As fast as the sewer filled up, the nozzle was withdrawn. Occasionally a projection extended into the sewer which prevented the removal of the nozzle and necessitated excavating from above before the nozzle could be freed. Regulating the water supply was also found rather difficult but the water content was of little importance as concrete of high quality was not required.

Cement and sand were used in the proportions of one part cement to ten parts of sand. About 220 lin.ft. of sewer was filled per shift, in which the cement gun was

in operation only 3 hr., the remainder of the time being used to move equipment and to excavate to free the nozzle and material hose inside of the sewer.

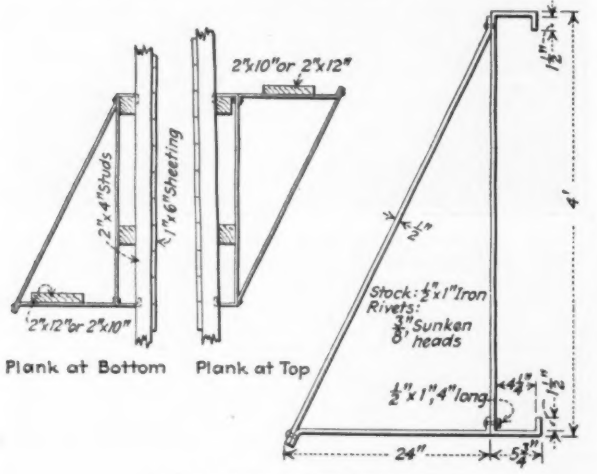
The work was done by the Cement-Gun Co. (Great Britain) Ltd., London, England, and the foregoing information was furnished by the Cement-Gun Co., Inc., Allentown, Pa.

Iron Bracket Supports Staging on Formwork

By Daniel McFarland
Storrie, Calif.

A LIGHT iron bracket, which can be easily handled and placed, has been designed by the writer for use in supporting staging on formwork. It has the advantage that it can be used in either of the positions shown in the accompanying sketch and with either built-up formwork or panels.

The planks used with the brackets should be carefully selected, rough, No. 1 Douglas fir, free from knots or



DETAILS OF IRON BRACKET

cross-grain. The ends of the planks should be bound with metal nailing strips to prevent splitting. By painting or staining the planks with a cheap paint it will be easier to prevent their use for any other purpose than for staging. Cleats should be fastened near the ends of each plank to prevent their slipping when the brackets are not placed level.

Method for Testing Bond Between Concrete and Its Reinforcing

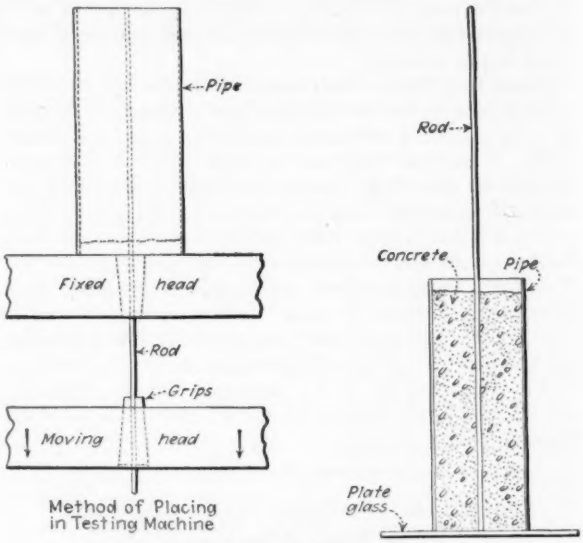
By Ross C. Durst
Professor of Civil Engineering, University of Akron, Akron, Ohio

A SIMPLE method for determining bond between concrete and steel reinforcing, in which the concrete is not placed in compression in the test, has been used by the writer in his classes for a number of years.

A section of pipe, 3 in. in diameter or larger and about 8½ in. in length, is sawed off squarely at both ends. It is then placed on end on a piece of slightly oiled plate glass. The steel rod is then set in the center of the pipe and concrete is placed around it, filling the pipe to within ½ in. of the top. The rod extends well above the top of the pipe. In determining the bond, the rod is pulled out by a testing machine in the usual manner,

From Job and Office

Hints That Cut Cost and Time



DETAILS OF BOND TESTING DEVICE

except that the open end of the pipe rests against the fixed head of the testing machine. This prevents compression in the concrete which probably exerts a pressure against the rod. The concrete will not pull away from the pipe because the area between the pipe and concrete is much larger than the area between the rod and the concrete.

Controlling Strains on Bronze-Welded Cast-Iron Pipe Lines

FAILURES have amounted to less than 1½ per cent of a total of 20,000 joints made on 50 bronze-welded lines in various sections of the country according to information recently published in *Oxy-Acetylene Tips*. Since all the breaks occurred in winter, it seemed that temperature change was responsible either directly by causing the pipe to contract or indirectly by causing ground disturbances. However, to secure specific reasons for this breakage, a comprehensive investigation was undertaken by engineers of the United States Cast Iron Pipe & Foundry Co. and by the Linde Air Products Co., who have published the results of their study in a pamphlet entitled "Controlling Temperature and Bending Strains in Bronze-Welded Cast Iron Pipe Lines," by E. Haring, F. G. Outcalt and T. W. Greene. This investigation was based upon an experimental bronze-welded line 1,604 ft. long of 6-in. Class 150 plain end de Lavaud centrifugally made cast-iron pipe. Expansion joints of various types divided the line into sections ranging in length from 82 to 450 ft. and pits were constructed so that measurements of ground and pipe temperature, movement of the pipe and strains induced in the line could be made at any time and under any weather conditions. Steam and water connections were provided for the purpose of making accelerated tests of temperature change. The following notes are taken from the report.

From Job and Office

For Contractor and Engineer

Special care was taken to insure straight jointed sections, two timbers being placed under each pipe for several lengths and graded by blocking to form a truly plane table. Eight or ten lengths were welded above the trench by rotation during welding. Welded sections were lowered with tripods spaced approximately 35 ft. apart. Horizontal bends occurring in the laying of the line were easily seen and straightened. Vertical bends are not so easily noticed, so the trench should be carefully graded to eliminate any sags or humps.

Backfilling, particularly around the lower half of the pipe, is considered one of the most important factors in laying bronze-welded cast-iron pipe. The initial backfilling is best tamped with a two by four. The rest of the backfilling is of comparatively little consequence and may be done by any method so long as large boulders are not allowed to fall from any considerable height onto the pipe.

Theory, checked by actual measurement, shows that the expansion and contraction of a buried line held under constraint by the friction of the backfill varies with the square of the temperature change. In short sections of pipe, 100 ft. or less, the maximum temperature stress never exceeds 4,000 lb. per sq.in. Since the maximum stress of 3,000 to 4,000 lb. per sq.in. is well within the safe strength of the material, expansion joints should be placed approximately every 100 ft. or every 8 to 10 lengths.

On this experimental line an immediate temperature change from 150 to 40 deg. F. resulted in no broken joints and the line held perfectly. The success of this line and its ability to resist the severe stress imposed by the various tests was believed to be due largely to the fact that bending strains were eliminated during construction.

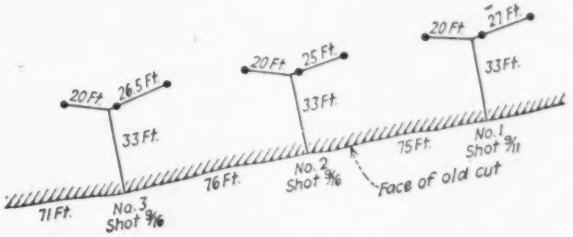
Blasting Railroad Cuts

COYOTE tunnels, bootleg holes and down-holes are used in shooting cuts on railroad work, as explained in the *Explosives Engineer* by J. G. McFee, of Henry & McFee, railroad contractors, Seattle, Wash. The substance of his paper is as follows:

On the west coast the customary method of blasting large cuts, particularly those on steep slopes, is to drive coyote tunnels close to the grade, normal to the center line, and into the upper slope line of the cut. With light air drills we make these drifts as small as possible. Cross-cuts from each coyote tunnel are necessary if the cut is large; these cross-cuts have three powder pockets, one at the intersection and at each end.

If the holes are dry, black powder is ordinarily used, otherwise 20 or 40 per cent dynamite. In shooting wet cuts where the type of material would indicate that black powder should be used, good results have been obtained by putting the powder in large bags of heavily paraffined canvas. This, of course, applies to coyote and bootleg shots where large containers can be used. The explosives are placed in the powder pockets, which lie either below the tunnel grade or in one wall. The amount of charge varies according to whether the rock from the cut is to be wasted or saved for haul, the character of the rock, and the amount of overburden. Perhaps one pound of black blasting powder for each cubic yard of rock to be broken is a fair basis of estimating explosive amounts in coyote shots used for blasting in areas of hard rock.

After loading, the pockets are tamped and holes are fired in groups of two or more, depending on the size of the cut and the demand for rock tonnage. Much trouble has resulted by shooting many holes with the ordinary hand-electric blasting machine, because of the failure of some holes to fire. Experience has proved that when 30 to 75 charges are to be detonated from one electric circuit, one or more misses are frequent. This is dangerous to muckers and also detracts from the efficiency of the blast. Whether the missed holes result from defective wiring, defective detonators or insufficient current has not been established. But there are missed holes even after the blasting machine, circuit and detonators have been tested. Lately, we have been using cordeau in place of electric exploders and since standardizing on this mode of detonation there have been no missed holes.



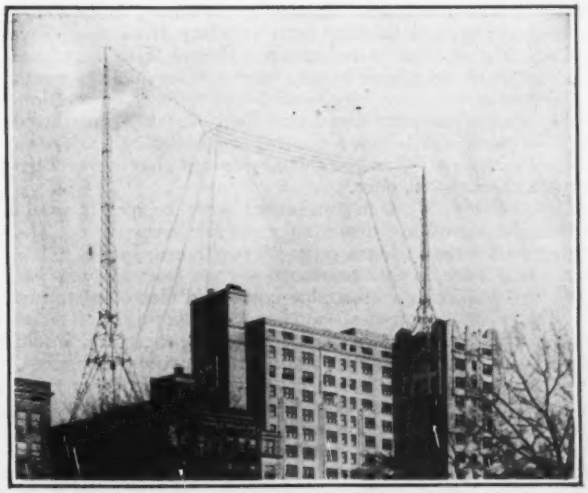
COYOTE HOLES FOR A RAILROAD CUT
Overburden 40 ft. deep

Bootlegs, a variety of coyote holes, are small holes driven from the outside into a bank as far as can be economically reached with long-handled shovels and bars. The practical depth limit of the holes is 20 ft. Most down-holes and block-holes are driven by jackhammer drills fed from gasoline-driven, portable air compressors. It is customary to spring such holes once or twice to form pockets large enough to hold the amounts of explosives necessary for breaking the burden.

In our blasting work the black powder (in 25-lb. cans) and 20, 40 and 60 per cent dynamite (in 50-lb. boxes) are transported in wagons over rough, temporary mountain roads. As yet there have been no accidents resulting from this mode of carriage.

Job and Office Notes

TWO WELDED STEEL RADIO TOWERS, 100 ft. and 175 ft. in height, were recently installed on the roof of the Whittier Hotel, Detroit, Mich. The towers were electrically welded and were manufactured in the shops of the National Iron & Wire Co., Cleveland, Ohio. They were shipped in sections and nested together. Joints were made, using twice the weld metal necessary for shear and no warping or deformation from the welding heat occurred in any of the members during construction.



Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Water Meters Urged at Chicago Twenty Years Ago

Sir—I was much interested in reading the editorial note and article on the water meter situation in Chicago under Mayor Thompson, in your issue of Aug. 11, 1927, pp. 249 and 263 and ran across an item in *Engineering News* for June 1, 1905, p. 583, which, it seems to me, may have a special interest at this time. It is as follows:

> "The installation of water meters at Chicago is strongly urged by John Ericson, city engineer, in an official report just made public. Mr. Ericson points out the magnitude of the water-works expansions in progress and projected, the great waste known to exist, and makes a strong plea for curtailing the waste by the use of meters."

It is over twenty years since this agitation began and before long by force of circumstances Chicago will be compelled by the united force of the courts, the War Department and public opinion to adopt the method common in most large cities, and many small ones too, of restricting within reasonable bounds the use of water for domestic and other purposes.

W. I. SWANTON.

Washington, D. C.,
Aug. 27, 1927.

Timber Frame Industrial Buildings

Sir—The writer has read with interest the commentary by R. S. Moulton, assistant secretary, National Fire Protection Association, in your Aug. 4 issue, p. 192, relative to heavy timber construction. It is doubtless true as he states that fires in industrial buildings involve expensive interruptions to business, in addition to the direct property damage, and the National Fire Protection Association is much to be commended for its altruistic efforts to prevent such interruptions. It does not appear, however, if automatic sprinklers are as effective as conceded by Mr. Moulton, that a business interruption is more likely or more serious in a heavy timber building than in any other type, as might be inferred from his letter. Experience indicates, in fact, that such buildings are thoroughly satisfactory from this viewpoint. The Boston Manufacturers Mutual Fire Insurance Co., for example, which insures over a billion dollars worth of industrial property, largely of heavy-timber construction, publishes the statement that a mill-floor, suitably constructed of 3-in. plank and 1-in. top flooring supported by timbers on 8 or 10-ft. centers, and without openings, has never been burned through but once.

Even if Mr. Moulton's inference were correct it would hardly be significant from an economic viewpoint. The article in question (*Engineering News-Record*, July 7, p. 20) states that heavy timber construction costs from 15 to 25 per cent less than other comparable types, and that obsolescence invalidates depreciation allowances. The saving in interest charges on the more economical structure, therefore, would more than pay for insurance against interruption to business, such as is carried by many concerns. A four-story reinforced-concrete building 90 ft. wide and 200 ft. long costs in round figures, $182,000, according to an article appearing in the same issue as Mr. Moulton's letter. Interest at 6 per cent reduction on a 20 per cent reduction of this cost, possible with heavy timber construction, would amount to $2,184 a year, which at prevailing rates for sprinklered occupancies should provide generous insurance against interruption of business.

In stating that waterproofing of floors in a timber-frame building is a troublesome problem, Mr. Moulton omits the fact that it is a troublesome problem in other construction types also. It is not unusual to take a short-sighted view of fire losses in relation to building economics. The country's entire present equipment of buildings, amounting in value to perhaps 100 billion dollars, could conceivably be replaced over a term of years by highly fire-resistive construction, recommended by insurance interests, at a cost of 25 billion dollars more than for types now customary. Interest charges on the additional 25 billions of productive capital thus tied up would be a billion and a half, or *three times* the annual fire loss reported for buildings and contents.

FRANK P. CARTWRIGHT,
Engineer, National Lumber Manufacturers Association.

Washington, D.C.,
Aug. 24, 1927.

Sewer Service at Manila Charged for on Metered Water Consumption Basis

Sir—The article "Financing the Baltimore Sewerage System" in your issue of May 5, 1927, p. 724, by Messrs. M. J. Ruark and C. E. Keefer, suggests that charges for sewerage service should be based on the quantity of water used. The city of Manila instituted this charge on my recommendation in 1910, basing the charges on the meter registration. Our water supply is 100 per cent metered, and the sewer service of the city is a part of the activities of the Metropolitan Water District. A copy of our rules and regulations is inclosed.

A. GIDEON,
Manager, Metropolitan Water District.

Manila, P. I.,
June 7, 1927.

[The charge for sewer service is 2½ centavos per cubic meter of sewage discharged into the sanitary sewerage system. For water supply the charge is 5 centavos per cubic meter for the first 300 cu.m., monthly, and 4 centavos for any quantity in excess, but every consumer must pay for an average of 500 liters a day. There is an annual charge for maintenance and upkeep of meters "and the pipe lines from the street main to the meter" varying from 1.20 pesos for ½-in. pipe to 30 for 6-in., the charges for ¾- and 1-in. pipe being 1.6 and 2 pesos per year. (1 peso = 50c.) Sewer connections from the street sewer to the property line and water connections from the street main to the meter are made at the expense of the consumer, as also the provision and installation of meters, but the work is done by the district. Sewer connection charges are all uniform at 7½ pesos per lineal meter for half the width of the street in streets unpaved or surfaced with macadam. In streets with an "improved pavement," the user must pay the city, in advance, the cost of street repairs necessitated by the connection.—EDITOR.]

American Society of Civil Engineers Admissions

Sir—The corporate members of the American Society of Civil Engineers are now voting on an amendment to the constitution regarding admissions.

The writer is sorry that he must differ with the distinguished gentlemen who signed the amendment. The writer's reasons for voting against the amendment are:

1. It seems inadvisable to tinker with the constitution every year.

2. The change of the age of admission of members and the lengthening of experience of associate members is an unnecessary move toward conservatism. The present minimum age limits are thirty years for members and twenty-five years for associate members. Actually the records of the society show that the average age of admission of members is forty-five years and of associate members thirty-five years.

3. We want live, young engineers in our membership. The writer is not in favor of letting down the bars but he feels that if this conservative movement continues the average age for admission of members will be advanced to fifty-five instead of forty-five.

He hopes the membership will defeat this amendment.

LEWIS D. RIGHTS,
Vice-president and Contracting Manager, Shoemaker Bridge Co.

New York City,
Sept. 3, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Ten of Twelve Estuary Tube Segments Now in Place

The tenth segment in the tube for vehicular and electric railway use that is being built under the estuary at Oakland, Calif., was successfully lowered to place on Aug. 25, leaving only two more segments to be put down. These two are floating in the estuary, ready to go down, and are to be placed in September. The subway is now expected to be ready for use early in 1928. (See *Engineering News-Record*, Oct. 28, 1926, p. 692.)

The 1,000-ft. Oakland approach to the subway, built behind a cofferdam, is completed and two of the segments have been placed at this end. The Alameda portal building is completed and the cofferdam is in place for the 478-ft. open approach at this end. Eight tube segments have been placed on the Alameda end, carrying the tube past the center of the estuary channel. Five of the joints between segments in place have been opened on the inside, thus giving access to six of the segments whose joints are reported to be found entirely satisfactory.

After sinking the two remaining segments and pouring the joints it will remain to pour the concrete ceiling, sidewalks, etc., and to place backfill. On Sept. 1 the contract with the California Bridge & Tunnel Co. was reported to be 90.3 per cent complete with 76 per cent of the contract time elapsed. The portal building superstructures are to be built and provided with ventilating fans and other equipment under separate contract. Bids on these contracts are to be called for in the near future.

Highway Committees to Meet

For the purpose of preparing the program of the seventh annual meeting of the Highway Research Board, which is to be held in Washington, D. C., Dec. 1 and 2, the six research committees are to meet early in September. Members will report on their assignments and reports for the annual meeting will be prepared. It is planned that the program for the December meeting will be a résumé of completed research, researches believed to be urgently needed in particular fields, and researches on which definite conclusions have been reached during the past year. In addition to the foregoing, the committee on causes and prevention of highway accidents and the committee on low cost improved roads will meet during December to prepare their report for the December meeting. A special effort is to be made to interest the chemical engineers in this work.

Methods and Machinery Are Farmer's Needs

Agricultural Engineers Present Eight Farm Relief Proposals to President Coolidge

To aid him in preparing recommendations to Congress on farm legislation, President Coolidge on Aug. 30 was presented with eight proposals by the American Society of Agricultural Engineers, the proposals being made "as a means which will, in our judgment, contribute to the betterment of American agriculture." O. B. Zimmerman, president of the engineering society and an official of the International Harvester Co., headed the delegation which presented the proposals to the President. The great disparity between the agricultural and the city industrial worker is indicated in the proposals and betterment is seen largely in more efficient use of machinery and power.

An abstract of the proposals follows:

(1) We solicit interest in the consideration of all of the factors which will determine the farm worker's income and that due regard be given to the securing of increased production per farm worker and the lowering of the cost of production by the adoption of more efficient methods of operation and management.

(2) In financing agriculture greater emphasis should be placed on earnings than on estimated or speculative land values.

(3) Encouragement should be given to further development of industrial uses of farm products.

(4) Support should be given to a study of the problem of the transfer of surplus farm population to industrial activities.

(5) Endorsement should be given to an engineering study made in co-operation with the American Engineering Council and the American Society of Agricultural Engineers, with the object of securing greater production per worker and lowering the cost of production.

(6) In the organization of flood control measures due consideration should be given to the importance of retarding flood waters in the upper reaches of the drainage areas.

(7) Encouragement should be given to the development of an enlarged research program to support and supplement the work now being conducted by the state colleges, by experiment stations and by the various federal agencies in the solution of agricultural problems.

(8) Favorable consideration should be given to the request for the change of the status of the present Division of Agricultural Engineering in the Bureau of Public Roads, Department of Agriculture, to that of a Bureau of Agricultural Engineering, Department of Agriculture.

In their memorandum the engineers also stated that "Viewed nationally, there are four essential factors involved in agricultural production: the quantity of agricultural products, the quality of the products, the cost of the products to the consumer and the well-being of those engaged in the agricultural industry." The present problem in agriculture is to be found in the fourth factor since the others are felt to be satisfactory.

It was also pointed out that while some agricultural workers, through the efficient use of power and equipment, are producing as much per worker as the industrial producer, there are others who produce at a very high cost and live on a very low standard. "Machinery, power and proper engineering direction are vital factors in making an agricultural worker the equal of the industrial producer." American agriculture is, as a whole, the most efficient agriculture in all the world because it is the best equipped. A study of the relation between power and income shows that the income per worker has increased in almost direct proportion to the increase in the use of power."

The report also states that it is important that the development of new uses for agricultural products outside of the food product line be fostered. It is pointed out that largely in this way has the development of the steel industry been so rapid. It is also pointed out that most of agriculture has not seen fit to follow the product to the ultimate customer, whereas those branches which have made contact between the producer and the consumer have shown marked prosperity over those branches which have not.

Embezzlement Charged in Owens Valley Controversy

The official statement has been made by Will C. Wood, state banking superintendent of California, according to the Los Angeles *Times*, that a shortage of $430,000 has been found in the funds of the Owens Valley Irrigation District, managed by the Wattersons. In previous statements Mr. Wood declared that the collapse of the Inyo County Bank was caused by the embezzlement of more than $800,000 and that the embezzlement was for the purpose of aiding the speculative enterprises of the Wattersons and not for the purpose of aiding the Owens Valley neighbors of the Wattersons in a contest with the city of Los Angeles. To quote the *Times:*

Inasmuch as the Owens Valley Irrigation District was organized chiefly to prevent the purchase of Owens Valley land by the city except at prices satisfactory to the district, proof of peculation in its funds would be a decided negative to the theory that the Wattersons have been actuated by public spirit. The banking superintendent says his statements are based upon admissions made by the Wattersons themselves.

Plans for New Toll Bridges Are Approved

Three toll-bridge projects received the War Department's approval of location and clearances during the last week. They are for a bridge across the Delaware River between Levick St., Tacony, Philadelphia, and Market St., Palmyra, N. J. (Tacony-Palmyra Bridge Co.); a crossing of the James River a mile above Newport News, Va., to a point on Ragged Island, Va. (James River Bridge Corporation, Norfolk); and a bridge across the southern arm of San Francisco Bay between Little Coyote Point, 2½ miles east of San Mateo, and a point opposite in Alameda County (Frank C. Towne, Mark E. Noon, and A. W. Deuel).

The Tacony bridge, which is a short distance above the Pennsylvania R. R. bridge connecting its main lines west of the Delaware River with the Atlantic City line, is to be a low-level structure with draw. The application was strongly opposed by the Atlantic Deeper Waterways Association and other maritime interests on the score of limiting the possibilities of navigation development on the Delaware above Philadelphia. The Little Coyote Point bridge project is for a structure 7 miles nearer San Francisco than the Dumbarton highway toll bridge put in service last year, or about 17 miles in an air line from the Ferry building, San Francisco. The plans are for a low-level bridge 27,560 ft. long, most of it consisting of concrete trestle. A 270-ft. lift span for 135-ft. maximum under clearance and two 300-ft. steel flanking spans are included.

Changes Proposed in Railway Ownership

The Seaboard Air Line Ry. Co. has applied to the Interstate Commerce Commission for authority to acquire the stock and to lease the properties of the Georgia, Florida and Alabama Railroad Co., a railroad extending from Richland, Ga., to Carabelle, Fla., a distance of 181 miles, with a branch line to Quincy, Fla., 11 miles long. A supplementary application is that of the Georgia, Florida & Alabama Railroad Co. for authority to issue bonds and stock to be exchanged for the bonds and stock of the Georgia, Florida & Alabama Railway Co. and the dissolution of that company.

Another application before the Commission is that of the Pittsburgh & West Virginia Railway Co. for authority to acquire control of the Wheeling & Lake Erie Co. by purchase of its capital stock. The Pittsburgh & West Virginia operates over its own line from Pittsburgh to Pittsburgh Junction and to a connection with the Wheeling over the West Side Belt Line, which is controlled through stock ownership. The Wheeling owns and operates lines extending from Terminal Junction to Cleveland, Lorain, Huron and Toledo, connects with the Pennsylvania, B. & O., New York Central, Nickel Plate, Wabash, and other lines and has trackage rights over the Baltimore & Ohio to Wheeling, W. Va. The combination of these two railroads will form the shortest route between Pittsburgh and lake ports under one management.

Control of the Wheeling through stock ownership passed to the New York Central, B. & O. and the Nickel Plate when O. P. Van Sweringen sold his stock to them some months ago. The Interstate Commerce Commission has not yet approved of this transfer of control.

Engineering Fifty Years Ago

From *Engineering News*, Sept. 8, 1877

THE water commissioners of San Francisco offered $9,500,000 for the Spring Valley water-works, but the company declined the price. They will now look to the Blue Lakes for the supply.

* * *

The channel span of the bridge over the Ohio River, at Cincinnati, Ohio, built by the Keystone Bridge Co. for the Cincinnati and Southern Railway Co., was swung clear of the false works last week. This is the largest span—520 ft.—of truss bridge in the world. The upper chord is 185 ft. above the ordinary water, and weighs about 1,300 tons.

* * *

Messrs. Cramp & Sons have now completed, with the exception of the boilers, the immense steam pumping engine which is intended for the Frankford water-works, Philadelphia. The entire machinery will be ready to go into operation by October 1. This engine was built at the contract price of $46,000, and has a pumping capacity of 10,000,000 gallons per day. It is a double-cylinder engine, the smaller cylinder being 40 in. and the other 60 in. in diameter. The pumps are 21 in. in diameter and 5-ft. stroke. The Frankford reservoir has a capacity of 36,000,000 gallons, to which have been run a 30-in. pumping main and 20-in. distributing main. There will be three boilers two of which will furnish steam for 500 horse-power. The third boiler will be held in reserve for emergencies.

Hoover Starts Survey of Progress on Flood Relief Work

On Sept. 2, Secretary Hoover started for the Mississippi Valley to make a survey of the progress in flood relief and to round out the rehabilitation plans. He also will study the economic conditions in the flooded region.

Final Plan For Reorganization of St. Paul Ry. Presented

Application for an early termination of the receivership, and for permission to take over control of the old Chicago, Milwaukee, and St. Paul Ry., was filed with the Interstate Commerce Commission on Aug. 18 by the new company, the Chicago, Milwaukee, St. Paul and Pacific Railroad Co. The objects of the reorganization plan are threefold: (1) To reduce the fixed charges to an amount safely within the earnings of the system; (2) To fund all early maturing obligations into long term obligations, to the end that the organization may have a breathing spell in which to recover from the period of depression through which it has passed and (3) To make adequate provision for financing future capital requirements, and for refunding underlying bonds at normal discounts and interest rates. Under the plan of reorganization approximately $70,000,000 in cash is to be provided by the stockholders and will be applied to liquidating the debt to the Government, for interest adjustment and for additions and benefits. Bonds are to be converted into income obligations to the extent of 80 per cent of their principal amount. By these and other changes the fixed interest charges are to be reduced from approximately $21,500,000 to $13,600,000.

Railroads Rendered Much Aid During Mississippi Flood

A summary of the aid rendered flood sufferers and for flood work in the Mississippi Valley by the railroads of that region has been prepared by the Committee on Public Relations of the eastern railroads. The railroads concerned are the Illinois Central, the Southern Pacific, Missouri Pacific, St. Louis-San Francisco, Texas and Pacific, St. Louis-Southwestern, Kansas City Southern, and Rock Island.

From the beginning of the flood up until the middle of June, the railroads had brought out 104,788 refugees, had moved 2,479 carloads of their household goods and live stock, furnished 4,794 cars for temporary living quarters and transported 504 carloads of food and supplies. In addition the railroad's own forces aided in strengthening and raising levees and handled a very large number of carloads of sand, rock and lumber for use on the levees. All this work was done without charge.

St. Paul Ry. Electrification Extended to Seattle

The electrified zone of the Chicago, Milwaukee & St. Paul Ry., which heretofore ended at Black River Junction, Wash., has been extended 8½ miles into Seattle. This gives the railroad company a completely electrified line from Othello, Wash., into Seattle, a distance of practically 230 miles.

Washington Notes

IT is apparent that Secretary Hoover is not one of those who is ready to sacrifice river control to tax reduction. Since his return to Washington there is new evidence that all of the influence which he possesses is being exerted to insure the handling of the Mississippi Valley's flood problem in a thorough way. Moreover, he is convinced that such an objective has public sympathy behind it to the extent necessary to insure that the job will be done right.

A mistaken impression was gained in some quarters from a statement which Secretary Hoover made recently while in the West. He was asked if the various pending water projects would not defeat tax reduction. In reply he attempted to make clear that the next Congress will consider only two river projects, that of the Mississippi and that of the Colorado. The two projects he figured roughly, as no engineering data are available, would not require authorizations at the next session in excess of $30,000,000.

The Colorado River project calls for $125,000,000, which would be spread over ten years, at least. This would leave practically $18,000,000 additional flood control money for next year or a total of $180,000,000 for the ten-year period over which the Mississippi program also probably will be spread.

The Secretary's estimate, of course, was not intended to be an exact one. If the engineering data should so indicate, he will not hesitate to revise his figures upward, but judging from the information which is available, Mr. Hoover is inclined to think that $28,000,000 is about as much as can be expended to advantage next year.

HEARINGS in connection with the application of the Potomac River Corporation for power rights on the Potomac had the effect of acquainting the public that there is much to be said in favor of developing the power resources of the river. So much newspaper space had been given to the objections to the project that much surprise is being expressed that so good a case was made for the project.

The hearings, which were before the United States engineer in charge of the Washington district, developed that practically all of the opposition comes from those who oppose any change in the natural state of the gorge of the Potomac. It was clear that the corporation is willing to go a long way to meet those objections. It was contended on its behalf that the gorge of the Potomac can be made more beautiful and more useful than at present, although it was admitted that the power project would alter the scenery.

HUGH L. COOPER, of New York, has applied again to the Federal Power Commission for a preliminary permit covering the "Z" Canyon project on Clark Fork of the Columbia River in Pend Oreille County, Washington, where he proposes to install ultimately twelve 50,000-hp. units under a head of 245 ft. The initial installation is to be six 50,000-hp. units. Nearly 200,000 hp. of primary power can be developed at the site, Colonel Cooper estimates. A prior application was rejected by the commission because the applicant was unable at that time to find a market for the power and because of his inability to secure state rights. In the meantime Colonel Cooper has reached an understanding with certain electrochemical manufacturers. In addition to the manufacturing load, a part of the power can be utilized for public utility purposes.

The state of Washington would not approve the first application for rights because of the status of the Columbia Basin project. Requirements of that development are now much better understood and Colonel Cooper is hopeful of securing the necessary state authority to proceed.

AN application to the Federal Power Commission has been made by B. G. Slining, of Chicago, for a preliminary permit covering a project on the Big South Fork of the Cumberland River near the Kentucky-Tennessee line. He proposes to erect a dam 375 ft. high and to install 80,000 kva. The application is in direct conflict with that of Edward Allen, also of Chicago, and also conflicts with the application of H. A. Spaulding for a smaller project which would be flooded out by either of the other proposed projects. The Spaulding project contemplates the utilization of a nearby site on the Obed River and another on the Obey River. The commission already has taken jurisdiction over the Cumberland site as a result of action on a declaration of intention filed by Mr. Spaulding.

The commission has been asked not to approve the design of the Diablo dam in its present form. Certain structural changes have been decided upon by the engineers planning the Skagit River dam for the city of Seattle.

New Floods Cause Heavy Damage in Poland

According to press advices new floods have caused serious damage with attendant loss of life in Poland. The New York *Times* of Sept. 5 reports that the County Commisar at Lemberg has learned that new floods have devastated many villages and towns and caused a loss of thirteen lives in Galicia.

In the Commune of Iwaniska, 350 homesteads have been inundated, the message said. In the Dolina district, twenty-seven villages and two towns were covered with water, two bridges collapsed and eight persons were drowned.

In the districts of Tlumacz, Kostrzow and Horochow, twenty-eight villages were virtually devastated, with a death toll of five. In Zabie 100 villages have been flooded.

Random Lines

Making Engineering a Hazardous Occupation

From an address on "Mississippi Flood Control" delivered before the Federal Spillway Board, by E. P. Lowe, M.D., of New Orleans.

"It goes without saying that in the construction of the impounding dam, the greatest skill obtainable and the most discerning and conscientious care and integrity should be employed and exercised. Any carelessness, incompetency, or dishonesty practiced in this work would subject the people living below the dam to great danger; hence such deficiencies and delinquencies should be promptly detected and rigorously weeded out and punished. It is doubtful if the fine or imprisonment system of penalization, or both combined, would suffice to prevent the injection of carelessness and dishonesty into this great and most serious national enterprise. Capital punishment might prove the only deterrent. Experience only would determine this point. And to promptly adjust such charges, special courts might be created and ordered to hold their sessions in the vicinity of the works, in order that the accused might be promptly acquitted or condemned. Long and tedious trials would prove harmful, if not futile, in such cases. Where sufficient and competent witnesses, as would always be available, could be quickly had, there could be no excuse for protracted delays of justice. We are reminded here of the effective procedure of Xerxes, the Medo-Persian king, when about to invade Greece. To cross the Dardanelles, it was necessary to bridge it. Xerxes, therefore, ordered his engineer to build the bridge while the vast army was being levied. When the structure was completed and the army ready to begin its passage, a storm arose and destroyed the bridge. The king immediately executed the engineer, and gave orders to others to rebuild the bridge. It is useless to say that the second bridge withstood subsequent storms, and the Persian host passed over in safety to the European side, to be destroyed later, not by the storm of the elements but by that which arose in the soul of the heroic Greek."

* * *

New Uses for Centrifugal Pumps

Excavating contractors on the site of the new State Tower Building in the Bastable plat are experiencing considerable difficulty laying the foundation due to water seeping into pits sunk below the level of Onondaga Lake.

The fact that the foundation is the lowest ever sunk for a building in the downtown district here has presented engineers on the job with many problems. The main portion of the excavation is 22 ft. below street level and on the north side it goes 30 ft. below street level.

A centrifugal pump and auxiliary hand pump were put in use late yesterday to force the water to a lower level where it seeps into the gravel substratum. It is believed these pumps will prevent further hindrance of progress.—Syracuse *Herald*.

Personal Notes

LORAN D. GAYTON has been appointed city engineer of Chicago, Ill., assuming the office held for many years by the late John Ericson. Mr. Gayton has been in the city's service for fourteen years in the designing division of the bureau of engineering, as designer of pumping stations and other municipal structures. He is a native of Boston and graduated in engineering from the Universitp of Illinois.

JOHN J. MANTELL, resident vice-president of the Erie Railroad Co. at New York, resigned on Sept. 1 to go into private business. Mr. Mantell has been with the Erie for the past 26 years. During the war he served as terminal manager for the Port of New York.

J. H. HOSKINS, formerly bridge construction engineer for the Florida State Highway Department, has been appointed city engineer and director of public works for the city of Brunswick, Ga., where maintenance of municipal docks and railroad yards will be part of his work.

CLIFFORD R. WHYTE, formerly an assistant designing engineer in the city engineering department of Pittsburgh, Pa., has become a supervising draftsman in the Philadelphia office of the Pennsylvania R. R.

PAUL BAILEY, state engineer of California, who has also served as director of the State Department of Public Works since the death of the late W. L. McClure, has resigned from state service to become chief engineer of the Orange County Flood Control District and has asked to be relieved of his duties at the state capitol from Oct. 1. The county flood control work of which he will have charge involves extensive construction for which a $6,000,000 bond election is planned in the near future.

GEORGE S. KNAPP, who, since 1919, has been state irrigation commissioner of Kansas, has been appointed chief engineer of the newly-created Division of Water Resources, of that state. This division has been formed by a consolidation of the Kansas Water Commission and the Division of Irrigation of the State Board of Agriculture. The department as now constituted deals with problems of river control, flood prevention and irrigation.

J. M. PAGE, until recently state highway engineer of Oklahoma, has been made executive secretary of the Texas chapter of the Highway and Municipal Contractors. Mr. Page before the War spent seven years in the state highway departments of Maryland and Virginia, served in the Construction Division during the War, and then spent a year in the Delaware State Highway Department followed by a year in Oklahoma as engineer for the U. S. Bureau of Public Roads. From 1921 to 1924 he was engineer for the bureau in the Fort Worth, Texas, district, and then was state highway engineer of Oklahoma to June 1, 1927, being succeeded by CLARK MANDIGO.

JOHN RIGHTMIRE, formerly chief engineer of plans and surveys for the Oklahoma State Highway Department, has been made assistant state highway engineer in the department, succeeding DUDLEY JONES. Mr. Rightmire had during a previous period been assistant state highway engineer of Oklahoma but had resigned and gone to Arkansas and then to Louisiana. The new engineer of plans and surveys in the Oklahoma highway department will be MAJ. W. P. DANFORD, a resident engineer for the department on various projects for the past three years.

PROF. BEN H. PETTY has been placed in charge of highway engineering in the school of civil engineering at Purdue University. He is well known over the Middle West for his lectures on this subject and in the future will devote half of his time to engineering extension work with the rank of highway extension specialist, and the other half to teaching activities. G. P. SPRINGER has been appointed instructor in civil engineering, as has BEN BROWNE.

THE CURRIE ENGINEERING CO., INC., of Webster City, Iowa, announces the removal of its western office from Alhambra, Calif., to the Anderson Building, San Bernardino, Calif., where the company is associated with C. E. Johnson, formerly city engineer of San Bernardino, in general and municipal engineering practice and the design of outfall sewers and sewage treatment plant for that city.

LARS G. NILSON has resigned from his position as chief engineer of the Nilson-Miller Corporation, of Hoboken, N. J., to enter consulting engineering practice, but he will continue to serve the company as consultant and retain his interest in it. He has been active in the corporation for eighteen years. In his consulting practice Mr. Nilson will devote himself to the design and development of special machinery.

JAMES WILSON, Louisville, Ky., consulting engineer and former chief engineer of the Louisville Water Co. and the engineer who constructed the new Kentucky-Indiana bridge, has been named city engineer of Louisville, succeeding A. A. KRIEGER.

WAYNE TINER has been appointed city engineer of San Angelo, Texas. For the past year Mr. Tiner has been resident engineer at Waco, Texas, in connection with the construction of a new sewage disposal plant.

A. O. KAY, of Fort Pierce, Florida, has been appointed a resident engineer of the Florida Everglades by the state drainage board, with headquarters in West Palm Beach; he assumed his duties Sept. 1. Mr. Kay was formerly engaged in drainage investigation for the U. S. Department of Agriculture.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Boston, Mass., Sept. 13-16, 1927.

AMERICAN WELDING SOCIETY, New York City; Fall Meeting, Dever, Colo., Oct. 3-6, 1927.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual meeting, Dentroit, Mich., Sept. 19-23, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Columbus, Ohio, Oct. 12-14, 1927.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Fall meeting, Birmingham, Ala., Oct. 17-19, 1927.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Dallas, Texas, Nov. 14-18, 1927.

ASPHALT PAVING CONFERENCE: Under the auspices of the Asphalt Association and Association of Asphalt Paving Technologists; annual conference Atlanta, Ga., Nov. 28-Dec. 2, 1927.

HIGHWAY RESEARCH BOARD, NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual meeting, Washington, D. C., Dec. 1 and 2, 1927.

THE MICHIGAN ENGINEERING SOCIETY will hold its fall meeting in Jackson, at the Hayes Hotel, Nov. 11 and 12. L. E. Ayres, of Ayres, Lewis, Norris & May, Ann Arbor, is president and is in charge of the program.

Obituary

AMBROSE P. MERRILL, civil and hydraulic engineer, manager for the Salt Lake division of the Utah Power & Light Co., died Aug. 17 at a hospital in Salt Lake City after a long illness. Mr. Merrill was born in Utah in 1882, graduated in engineering from Utah Agricultural College in 1903 and received an engineering degree from the University of Utah in 1904 and from the University of Michigan in 1907. He spent a year in the city engineering department in Salt Lake City, practiced in hydraulic engineering, was hydraulic engineer for the Knight Investment Co. at Provo and then was general manager of the Knight Consolidated Power Co. at Provo. With the Utah Power & Light Co. he was in 1913 division manager at Provo and in 1919 division manager at Ogden, and later division manager at Salt Lake City.

T. TRUMAN BLACK, civil engineer, Toronto, Ont., died suddenly on Aug. 26 at the age of 52 years. Mr. Black was born at Dorchester, N. B., and graduated in 1906 from McGill University. He specialized on bridge construction and was first employed on the Intercolonial Ry. and later on the Canadian Pacific Ry.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Water Works Manufacturers To Exhibit in Boston

At the New England Water Works Association convention, which will be held at the Hotel Statler in Boston September 13-16, the following manufacturers will exhibit their equipment and have reserved space for this purpose.

American City
American Brass Co.
Badger Meter Mfg. Co.
Builders Iron Foundry
Byers Co., A. M.
Barber-Greene Co.
Central Foundry Co.
Chapman Valve Co.
Caldwell Co., Geo. A.
Cement Lined Pipe Co.
Eddy Valve Co.
Engineering & Contracting Co.
Engineering News-Record
Edson Mfg. Co.
Federal Meter Corp.
Giant Mfg. Co.
Gurley, W. & L. E.
Hersey Mfg. Co.
Kennedy Valve Co.
Lead Lined Iron Pipe Co.
Leadite Co.
Lock Joint Pipe Co.
Lead Hydro-Tite Co.
LaMotte Chemical Products Co.
Mueller Co.
McWane Cast Iron Pipe Co.
National Meter Co.
National Water Main Cleaning Co.
Neptune Meter Co.
Pitometer Co.
Pittsburgh Equitable Meter Co.
Pittsburgh-Des Moines Steel Co.
Public Works
Paradon Engineering Co.
Ross Valve Mfg. Co.
Red Hed Mfg. Co.
Smith Mfg. Co., A. P.
Snell Co., Geo. H.
Taylor Co., W. P.
Thompson Meter Corp.
Union Water Meter Co.
U. S. Cast Iron Pipe Co.
Wallace & Tiernan Co., Inc.
Water Works Equipment Co.
Wood & Co., R. D.
Worthington Pump & Machinery Co.
Water Works Engineering

Research Laboratory for Crushed Stone

At the recent meeting of the board of directors of the National Crushed Stone Association, at Atlantic City, it was unanimously agreed that there should be established in conjunction with its bureau of engineering a research testing laboratory, to be located in Washington. It was also voted that the officers of the association should take the necessary steps toward raising the additional revenue required for this purpose. In the *Crushed Stone Journal* for August, 1927, there are given some of the reasons why the association feels it should possess its own research facilities in addition to using those facilities which are offered in other laboratories. These reasons are listed as follows:

1. There are many problems in which the association alone has a primary interest and in which it cannot ask any disinterested laboratory to engage.

2. With a laboratory of its own the association will not have to obtain needed information in a circuitous manner not to mention being deprived of it entirely.

3. The association would be able to initiate investigations and carry them on to the extent of gaining confidence in asking others to carry them further for their own benefit as well as for that of the association.

4. Information now buried in the files of other institutions will be brought to light as the association obtains similar information and thus more data will become available.

5. Original investigation in its own laboratory will permit the writing of original, technical papers and thus not only will much prestige for the crushed stone industry be made possible but there will also accrue considerable advertising value from the resulting discussions.

6. Research facilities should gradually aid in increasing the membership in the association whose usefulness and value will thus be extended to the benefit of the entire industry.

Business Notes

YOUNG RADIATOR CO., Racine, Wis., has been organized to manufacture heavy duty radiators for buses, trucks, tractors, and power units. F. M. Young, former vice-president and general manager of the Racine Radiator Co., has been elected president.

A. T. KASLEY, formerly head of the research department, South Philadelphia works, Westinghouse Electric & Manufacturing Co., has been appointed consulting engineer, engineering department, at that plant.

HARNISCHFEGER CORP., Milwaukee, Wis., announces the establishment of two new agencies: Johnson-Beckwith Equipment Co., Davenport, Iowa, and the Northwest Equipment Co., Billings, Mont.

LAWRENCE MACHINE CO., Lawrence, Mass., announces that it has changed its name to the LAWRENCE MACHINE AND PUMP CO.

McWANE CAST IRON PIPE CO., Birmingham, Ala., is reported as increasing its preferred capitalization from $500,000 to $1,000,000. Only a sufficient portion of this new issue will be sold at the present time to complete improvements now under way. These are developments in mechanical operations which will be substituted for the hand methods that have been used in the initial stages for manufacturing sand cast pipe. It is expected that as a result of the new installations, the tonnage of the plant will be practically doubled. The length of the new pipe made in this mechanically equipped unit will be 16 ft. The range of sizes heretofore made will also be increased and pipe as large as 12 in. in diameter will be made in the new unit. The new processes are reported as all being covered by patents.

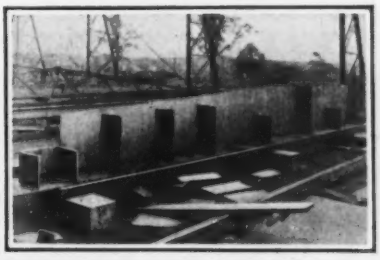
HADFIELD-PENFIELD STEEL CO., American Clay Machinery Co. and the Era Steel Co., all of Bucyrus, Ohio, have been purchased by the W. A. Riddell Co., Bucyrus, Ohio. W. A. Riddell, president and owner of the Frederick Iron & Steel Co., and president and owner of the Frederick Engineering Co., Frederick, Md., has been made president and general manager of the new organization. The line of one-man graders, crawler tracks for tractors, road rollers, scarifiers, rooters and wheel scrapers will continue to be manufactured and added to, according to a statement from the company.

New Developments

Traveling Crane Fabricated by Arc Welding

Designed especially for arc welded fabrication, a 10-ton overhead traveling crane with 60-ft. span has recently been constructed by the Cleveland Crane and Engineering Co., Wickliffe, Ohio.

Each girder is of fish-belly, box type, consisting of two webs and top and bottom cover plates, both cover plates being arc welded to the webs by a fillet bead. In addition to this weld still greater

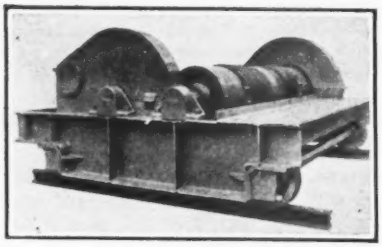


DETAILS OF WELDED CRANE GIRDER

strength is secured by welding a round bar along the webs and cover plates at each of the four corners of the box section. The area of this round bar is equivalent to that of the angle section which would ordinarily be employed in riveted construction. Girders are reinforced by diaphragms fillet welded to both webs and to the top cover plate. Welding these diaphragms to the top cover plate assisted materially in imparting rigidity to the crane. No attempt was made in the design to take

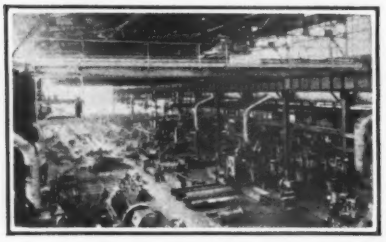
advantage of a possible saving in weight of plates.

The end trucks are of box section completely welded, the side members being standard rolled channels connected by top and bottom cover plates with stiffening diaphragms. In the trolley, the greatest advantages of arc-



THE COMPLETELY WELDED TROLLEY

welded construction is realized. Considerable weight is saved and at the same time greater rigidity and strength obtained. The side members are standard channels and the bed for the hoist and trolley travel mechanism is a flat plate with reinforcing plates arc welded under the bearing points. Wherever pads and bosses are required to form seats for the hoist and travel mechanism,



THE WELDED CRANE IN SERVICE

these are made by welding steel plate of the required dimensions to the structural parts of the trolley. In this manner machining was simplified. It is said that tests made at the plant of the Cleveland Crane and Engineering Co. have amply justified the engineers' estimates of improved design and saving in manufacturing costs.

Motor Truck Crawler on Exhibition Tour

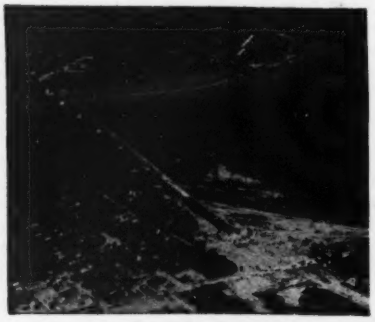
The recently developed crawler unit for attachment to motor trucks is being exhibited by the Universal Crane Co., Cleveland, Ohio, on a demonstration tour. The truck shown in the illustration left New York City July 1 for Cleveland. Job demonstrations were arranged along the route, showing how this unit can be applied to different types of construction work. The machine traveled over the road on its eight rubber tired wheels at a speed of 16 m.p.h. When it encountered work necessitating the use of the crawlers, these could be attached in approximately 10 minutes; its speed then is said to have varied from 10 to 14 m.p.h. Of the 750 miles which the machine has traveled, approximately 100 miles have been covered on the crawler treads. The company announces that it is the plan to send this demonstration unit to other parts of the country.

New Line of Six-Cylinder Trucks

A complete new line of six-cylinder 2-ton chassis trucks, available in three types, has been announced by Graham Brothers, the truck division of Dodge Brothers, Inc. A four forward speed transmission is said to assure surplus pulling ability for emergencies and makes possible moderate engine speeds for fast long runs. Another feature is the use of four-wheel hydraulic brakes. A 7-bearing crankshaft is also an important feature. The connecting rods are of chrome-vanadium steel and the pistons of light alloy. In the new transmission the first speed ratio is 6½ to 1, resulting in approximately 60 per cent increase in pulling ability compared with the first gear position of the three speed transmission formerly used on 2-ton models.

Modern Lighting Requirements Met on Peace Bridge

The illumination of the International Peace Bridge connecting Buffalo and



PEACE BRIDGE ACROSS NIAGARA RIVER

Fort Erie, Ontario, which was recently opened, is effected by the most modern of methods and marks the co-ordination of two widely different types of light distribution on one structure—broadly diffused light in general for the curved approaches and concentrated, directed light for the main roadway of the bridge. The plan adopted utilizes 56 lamps with one type of refractor on the curved approaches and 66 lamps with other refractors along the main roadway. A value of 4,000 lumens per lamp was chosen, but this intensity can later be increased to 6,000 lumens without expense for additional auxiliary equipment.

Two types of refractors manufactured by the Holophane Glass Co., Inc., New York City, were mounted in Westinghouse ornamental lighting units. Holophane's Superlux refractors were used on the curved approaches and Bilux refractors on the bridge. The height of light centers above the roadway is about 14 feet.

To insure continuity of service, power is provided from both the American and Canadian ends of the bridge, two transformers, rated at 15 kw. each, being placed at each end. One transformer supplies power for approach lamps on its side, while the other furnishes energy for alternate roadway lamps all the way across the bridge.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL HARDWOOD LUMBER ASSOCIATION, Chicago; Annual Convention, Chicago, Sept. 15-16.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; Semi-annual meeting, Aviation Country Club, Detroit, Sept. 19-21.

AMERICAN PAINT & VARNISH MANUFACTURERS ASSOCIATION, Philadelphia; Annual Convention, Atlantic City, Oct. 24-25.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York; Annual convention, Pinehurst, N. C., Oct. 25-29.

NATIONAL ASSOCIATION OF MANUFACTURERS; Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 16-19, 1928.

New Publications

Drifter Drills—INGERSOLL-RAND CO., New York City, devotes its most recent publication, Form No. 4063, to its Leyner-Ingersoll drifters. Many illustrations and considerable description are given of the uses to which the drills have been put in mine, quarry and tunnel. A list of the important tunnels upon which these drills have been used is given. Cross-sectional diagrams and photographs of details show the construction of the drills. The booklet contains 31 pp.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Cast Iron Pipe Market Depressed

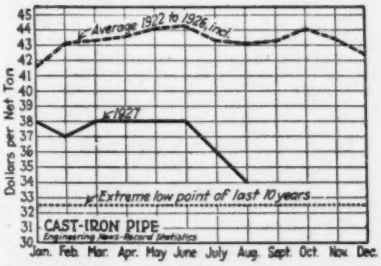
Price Close To Low Point of Last Ten Years—Drop In Water-Works Contracts—Imports Gain

A NARROW margin of $1.50 per ton is all that stands between the present price of cast-iron pipe, 6-in., Class B, f.o.b., Birmingham, and the extreme low point of quotations for the last ten years.

The current price of $34 per ton, base, Birmingham, is 21 per cent below the average August price ($43.20) for the period 1922 to 1926, inclusive. Quotations as of the first week in August for the five years mentioned, were as follows: 1922, $37; 1923, $49; 1924, $50; 1925, $40; 1926, $40.

Cast-iron pipe has followed pig iron in the downward movement. Prices of the latter now stand at levels approximately 17 per cent below those of 1922, taking an average of thirteen grades in six centers.

Another depressing influence on the market for the material in question is the comparatively smaller volume of contract letting for water-works construction.



PRICE F.O.B. BIRMINGHAM, CARLOAD LOTS, 6-IN. AND OVER, CLASS B AND HEAVIER

Average weekly value of awards for waterworks of $15,000 value and over, throughout the entire country, for July, 1927 was less than half that of the month preceding. This is contrary to the direction taken in 1926 in this particular class, since July, 1926 weekly average showed a gain of fully 24 per cent over June of that year.

The July, 1927 weekly average is also 41 per cent under that of the corresponding month last year. For the period Jan. 1 to Au- 1, 1927, water-works, at minimum mentioned, totaled $33,313,000, entire U. S., against $34,626,000 for the same months last year. This represents a loss of 6 per cent in actual money value, while the actual change in cost of construction (labor plus materials) was a small fraction of one per cent, average for the period.

It may be that imports are also exerting considerable influence on the market for cast-iron pipe, especially since the quantity shipped into the United States from foreign countries during the first quarter this year, was 149.6 per cent greater than the tonnage received for the same period last year.

This heavy increase in material received from other countries, is contrasted with the gain of only 12.4 per cent in tonnage of iron and steel tubular products (pipes, tubes and fittings) exported in the first quarter of 1927, compared with the same period of 1926.

The January-March figures are the latest available, on volume of principal exports and imports between the U. S. and chief foreign markets, as issued by the Chamber of Commerce of the United States.

The following unit costs of materials in place (furnishing and laying) on standard sizes, bell and spigot type, are included in low bidders' estimates on various projects, 1922 to 1927:

Location	Date	Tons	Price
Sewage treatment works Marion, O.	Aug., 1922	110	*$80.00
Water supply Tulsa, Okla.	Sept., 1922	24	*90.00
Sewarage system Dover, N. J.	Oct., 1922	32	*90.00
Conduits Brooklyn, N. Y.	Mar., 1923	140	101.60
Bridge Haverhill, Mass.	June, 1923	30	143.00
Tunnel Cleveland, O.	Nov., 1923	260	*82.50
Conduit New York, N. Y.	Jan., 1924	35	*90.00
Conduit Brooklyn, N. Y.	Feb., 1924	140	100.00
Watermains Cleveland, O.	May, 1924	995	*75.00
Conduit Brooklyn, N. Y.	Jan., 1925	100	100.00
Subway Sect. 1, R78 New York, N. Y.	Apr. 1925	350	100.00
Subway, Sect. 3, R102 New York, N. Y.	Dec., 1925	250	130.00
Viaduct Jersey City, N. J.	Mar., 1926	20	170.00
Subway, Sect. 6E1, R8 New York, N. Y.	Aug., 1926	20	100.00
Subway, Sect. 3 & 4, R1 New York, N. Y.	Dec., 1926	255	100.00
Sewage treatment works New York, N. Y.	Jan., 1927	25	180.00
Sewerage system Hunter, N. Y.	Mar., 1927	155	*80.00
Filtration plant Allentown, Pa.	Apr., 1927	149	*90.00

* Placing only.

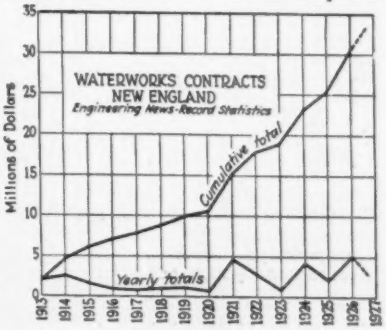
Water-Works Contracts in New England—1927 to Date Equal Same Period in 1926

AWARDS for water-works projects in New England in 1927 are less than one per cent under those of the first eight months of 1926, according to *Engineering News-Record* statistics which include all contracts of $15,000 and more.

During the fourteen years 1913 to 1926 the total value of awards in New England was $30,507,000. The peak year of that period was 1926, which comprised 16¾ per cent of the total. High totals were shown likewise in 1921 and 1924, these years comprising 15 and 14 per cent, respectively. The four years during which there were less than one million dollars of water-works projects contracted for were 1916, 1917, 1920 and 1923.

Unlike the total awards for all classes of construction throughout the United States, the water-works awards in New England show no continual and steady growth since 1921. Nor is there any correlation between water-works awards in New England and those throughout the country, except in the year to year change in 1914, 1915, 1919, 1921, and 1922. Throughout the Middle West and Far West new systems are being built in newly developed communities, while projects in New England for the most part involve replacements and improvements of existing systems.

Massachusetts, Rhode Island and Connecticut are the only states reporting awards of this class of construction in 1927; and in 1926, Maine was the only additional state in which contracts of $15,000 or more were awarded. Of the $2,842,000 during 1927, Massachusetts reports 77 per cent, or $2,198,000, and Rhode Island, 16 per cent. For the entire year 1926 Rhode Island awarded 46 per cent of the total waterworks contracts and Massachusetts only 36.



WATER-WORKS CONTRACTS NEW ENGLAND AND UNITED STATES
(Thousands of Dollars)

	New England	Cumulative	United States
1913	$2,006	$2,006	$20,779
1914	2,606	4,612	22,024
1915	1,486	6,098	21,547
1916	912	7,010	24,268
1917	825	7,835	27,934
1918	1,039	8,874	12,719
1919	1,040	9,914	19,762
1920	673	10,587	22,141
1921	4,618	15,205	38,330
1922	2,770	17,975	36,221
1923	947	18,922	62,698
1924	4,284	23,206	61,445
1925	2,203	25,409	69,368
1926	5,098	30,507	61,647
1927	2,842 (8 mo.)	33,349	41,213 (8 mo.)
1926	2,859 (8 mo.)		

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total U. S.
September 8, 1927..	$24,551,000	$35,468,000	$60,019,000
September 1, 1927..	23,155,000	49,774,000	72,929,000
September 9, 1926..	15,567,000	16,839,000	32,406,000
Jan. 1 to date			
1927	868,029,000	1,309,892,000	2,177,921,000
1926	788,140,000	1,226,237,000	2,014,377,000

E.N.-R. Index Numbers

On September 1, 1927

COST	VOLUME
203.60	306
Last Year 208.30	Last Year 252

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 48-page pamphlet entitled Engineering News-Record Construction Costs.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, per 100 lb....	3.34	—$3.75	$4.00	$3.10	$3.35	$3.87½	$3.10	$3.00	$4.00
Structural rivets, per 100 lb.....	5.00	+4.00	4.75	+3.60	3.75	4.64	+5.50	5.25	5.50
Reinforcing bars, per 100 lb.....	3.24	+2.99	2.75	2.50	2.87½	3.77½	2.95	3.00	3.57
Steel pipe, black, 2½ to 6 in., lap weld, discount from list	48%	+40%	54%	51%	48%	41%	42@53.8%	48%	.....
Cast-iron pipe, 6 in. and over, per net ton	44.60	—36.50	54.00	—40.20	46.50	56.50	43.00	55.00	41.00
Concreting Material									
Cement, without bags, per bbl. .	2.35†	2.40	2.05	2.05	2.22	2.85	2.51	2.65	1.42
Gravel, ¾ in., per cu.yd.....	1.75	2.20*	2.38	2.00	—1.25*	1.90	1.80	1.25	1.90*
Sand, per cu.yd.	1.00	+1.75	2.00	2.00	1.25†	1.00	1.40	1.25	1.35*
Crushed stone, ¾ in., per cu.yd...	1.85	2.50*	2.83	2.00	—1.25*	2.50	1.70	3.00	2.00*
Miscellaneous									
Fir, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	.....	.....	.....	—38.50	38.75@39.75	34.25	27.00	24.50	55.00
Pine, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.....	62.00†	34.00	56.00†	.....	.....	.....	.....	.....	.....
Lime, finishing, hydrated, ton...	17.45	24.50	19.00	20.00	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl ..—2.10@2.35‡		1.35	1.82	1.50	1.70	2.70‡	1.70	2.80‡	10.00*
Common brick, per M	17.00†	12.50	13.60	12.00	13.75†	8@12	14.00	14.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0724†	.103	.....	.072	.085	.....	.10	.10
Hollow partition tile, 4x12x12, per block	.1027	.0724†	.103	.076	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	+.86¼	— 87¾	—.85	+.84	90¾	—1.01	.92	.98	1.03
Common Labor									
Common labor, union, per hour.	.90⅜	.30	.....	.90	.....	.....	.60	.70	.....
Common labor, non-union, hour.	.....	.25	.30@.50	.82½	.45@.60	.31¼@.50	.50	.62½	.30@.35

*Ton. †Delivered. ‡280-lb. net. +Advance. —Decline.

PRICE declines continue in excess of advances at the principal building material distributing centers throughout the country. The fact that 5 per cent more money has been spent for construction thus far this year, than was represented in contract totals for the corresponding period of 1926, does not serve to make the market any firmer.

Changes of the last fortnight involve upward price movements in structural rivets, reinforcing bars, steel pipe, and building sand at yards and warehouses in the cities indicated in the table. Declining tendencies were evident in round-lot shipments of steel shapes, cast-iron pipe, crushed stone, gravel, fir timbers, and common lump lime.

Despite the earliest summer frost in thirty-six years, which occurred August 1 in the Grand Forks, N. D., region, linseed oil prices throughout the country show two declines to each advance. Raw oil in 5-bbl. lots is 90¾c. per 7½-lb. gal. at Minneapolis, compared with 93c. on Aug. 18.

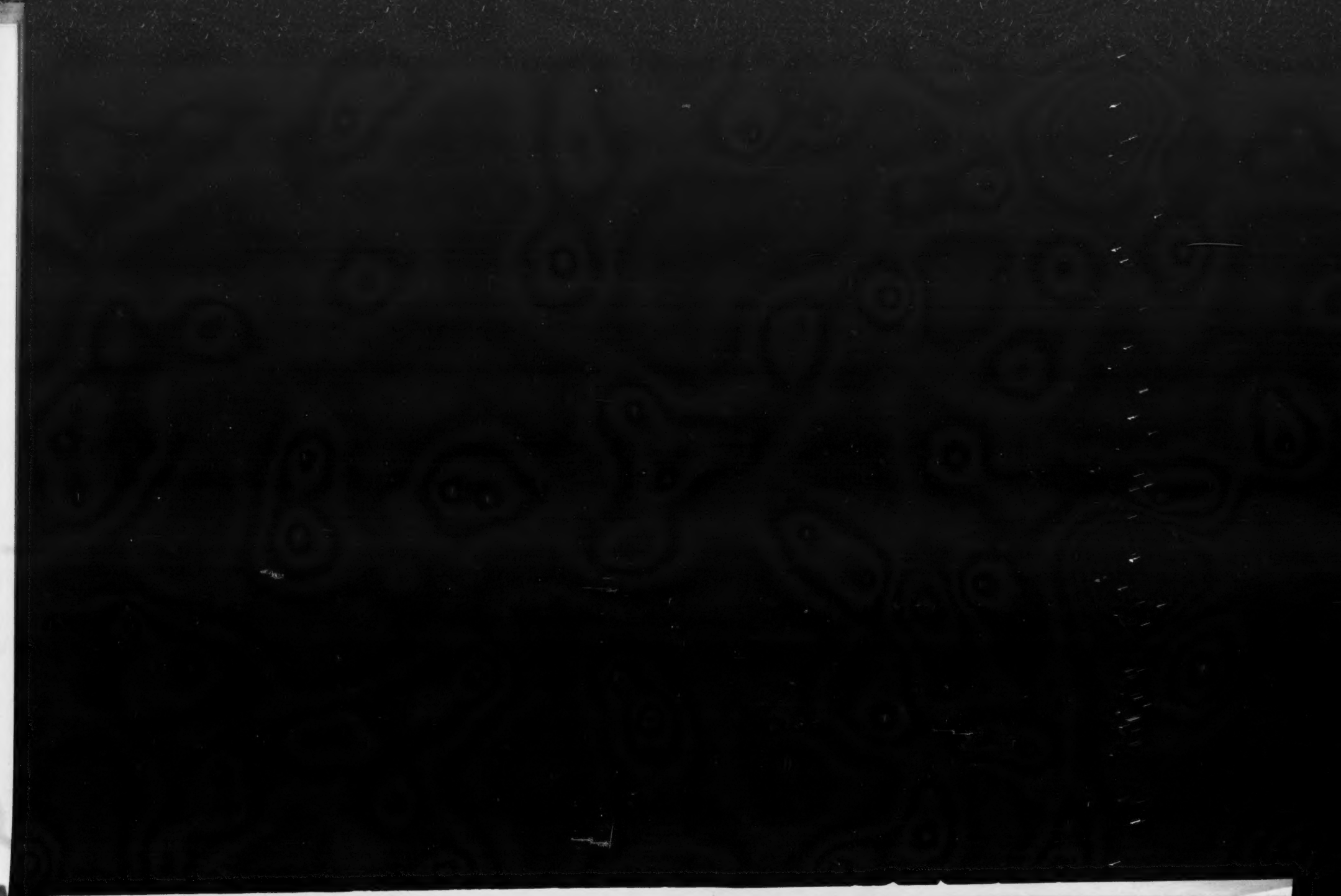
THIS limited price list is published weekly except in the first issue of each month and gives current prices on the principal construction materials in the chief cities. Valuable suggestions on costs of work can be had by noting actual biddings as reported in the Construction News and Unit Prices sections following.

The first issue of each month carries complete quotations for all of the basic materials and for the rest of the important cities, also wage rates for the principal building trades and common labor. The last complete list will be found in the issue of Sept. 1, the next on Oct. 6. Explanation of prices contained in the table will appear from time to time in this section; last shown Aug. 11, 1927, p. 247.

Comparing the current levels with prices in effect at this time last month, it is found that declines are considerably widespread in boards, planks and timbers, common brick, sewer pipe, clay drain tile, and light rails. Pig iron continues weak. Marked improvement over August's markets is noted in iron and steel scrap and track supplies.

Direction of demand for construction materials is fairly well indicated by proposed work. Total value of projected construction reported during August was 2.6 per cent greater than that for the month preceding and 21 per cent under the August, 1926, level. All classes showed gains over July except sewers, excavations, commercial and public buildings, and Federal Government work.

Increases were confined to New England, the South and the States west of the Mississippi.

UNIT PRICES

For actual prices bid on materials in place at various construction jobs throughout the country see pp. 128-128a of this issue, following Construction News